OCTOBER 5, 1959
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Chemical Engineering

A McGRAW-HILL PUBLICATION

BYPASS THE PILOT-PLANT WITH *Speculative Process Design* BASED ON THESE KEY MECHANISMS

MATERIAL BALANCE
First law of thermodynamics.
Readily solved if all data are available.

$$\frac{\partial M_i}{\partial t} = \sum_j m_{ij} + \sum_k G_{jk}$$

ENERGY BALANCE
First law of thermodynamics.
Readily solved if all data are available.

$$\sum_j m_j \left[\frac{u_j^2}{2\, g_c \alpha_j} + (g\, z_j/g_c) + i_j\right] = Q - W$$

PHASE EQUILIBRIUM
Second law of thermodynamics.
Readily solved if all data are available.

$$dF = -S\,dT + V\,dp$$

$$\mu_i = \left(\frac{\partial F}{\partial N_i}\right)_{p,T,N_1 \ldots N_n}$$

CHEMICAL REACTION EQUILIBRIUM
Second law of thermodynamics.
Readily solved if all data are available.

$$\frac{(a_{P1})^x\,(a_{P2})^y}{(a_{R1})^a\,(a_{R2})^b} = k_a = e^{-\frac{\Delta F^\circ}{RT}}$$

AHEAD IN HEAT TRANSFER
CONTROL GAS-PHASE REACTIONS
HIGH-PURITY ETHYLENE
PAGE 3

New! EPON® RESIN 1002

When it's hot it pours!

Now you can say good-by forever to the hot weather annoyance of having granular resin solidify in the bag. *Shell Chemical's new Epon resin 1002 will not sinter even when your workroom temperature crowds the 100 mark!*

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Epon 1002 is similar in performance to Epon 1001. Coating systems based on either resin give superior impact resistance, flexibility, plus excellent resistance to water, boiling caustic, many acids and most solvents. If force curing is desirable, Epon 1002 coatings are resistant to over-bake.

For greater ease in handling, Epon 1002 is packaged in 50-pound, polyethylene-lined, multiwall paper bags . . . simple to store and use. For complete information, including technical bulletin SC:58-107, write to your nearest Shell Chemical district office.

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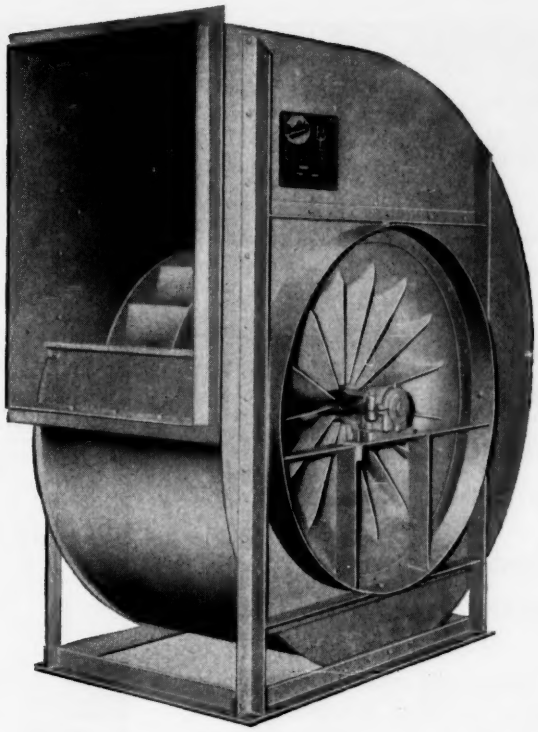

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Be sure to investigate the "Buffalo" Type "BL" Fan for your Class I and II air moving jobs. Call your nearby "Buffalo" engineering representative, or write for Bulletin F-104.

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October 5, 1959

Chemical Engineering

Vol. 66 No. 20

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

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*FREE—for your files—Check Reader Service postcard (p. 211) for an extra copy of the latest in the continuing CE Series of cost-estimating data.

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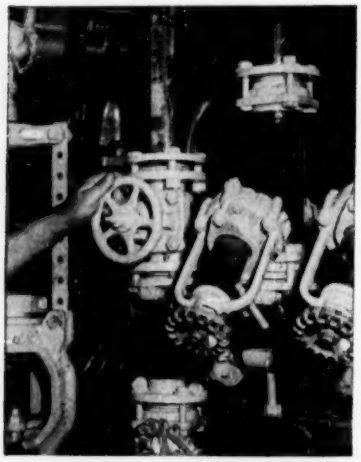
PENTON® PRICES CUT 40%

Growing list of commercial uses for new corrosion-resistant plastic now includes pipe and tank linings.

Wilmington, Del.—Hercules Powder Company has announced reductions ranging up to more than 40% in the price of Penton, new corrosion-resistant plastic. The reduction effects a complete revision in the price structure of this new chlorinated polyether thermoplastic, reflecting its new status as a commercial product.



This Penton-lined Hills-McCanna valve has already been in service for more than 45 months in a severely corrosive environment.

Separate price categories have been established for natural formulations, and olive drab and black formulations. All were formerly priced at $6.00 per pound. The new base price of natural Penton in 6000-lb. quantities is $3.50. The corresponding base price for olive drab and black Penton is $3.75. Substantial reductions over the former price have also been effected in other quantity categories.

The complete Penton processing package includes pipe and fittings made with solid Penton, or Penton-lined metal.

CHEMICAL INERTNESS

Penton is a chemically inert industrial plastic providing a broad spectrum of corrosion resistance, particularly at elevated temperatures. It is already well-established in a variety of anti-corrosion uses as a result of 5 years of product development during the time when only limited commercial quantities of material were available.

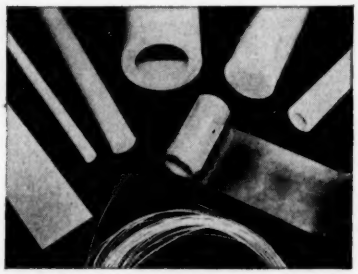
G. M. Taylor, supervisor of Penton sales, says that the price reduction is expected to greatly expand established markets for Penton, and at the same time stimulate and broaden its acceptance in new applications. It reflects the savings in production costs which will be possible in the operation of a large-scale commercial plant.

At its new price Penton, which was already substantially lower in cost than high-priced metals and alloys in many corrosion-resistant uses, will offer economies over a broad list of conventional and synthetic materials in the whole range of industrial uses where its application is indicated.

THE PENTON CORROSION PACKAGE

Valves, pump parts, pipe, tubing, fittings, flow meters, and corrosion-resistant meter parts are included in the list of Penton products now commercially available. The list of uses continues to grow and now includes precision molded gears and bearings, tank linings, drum linings, gaskets, and closures.

Penton can be economically formed by compression and injection molding and extrusion. It is readily fabricated or machined from sheet, rod, or block stock. It can also be applied as a coating on metal surfaces, giving them greater durability in a wide range of adverse environments.



Penton sheets, rods, and tubes are now commercially available for use in the custom fabrication of processing components or pilot models.

Penton coatings and linings provide an economical means of producing corrosion-resistant vessels of various sizes and shapes.

HERCULES

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INCORPORATED
900 Market Street, Wilmington 99, Delaware

CP59-14

Chemical Engineering

October 5, 1959

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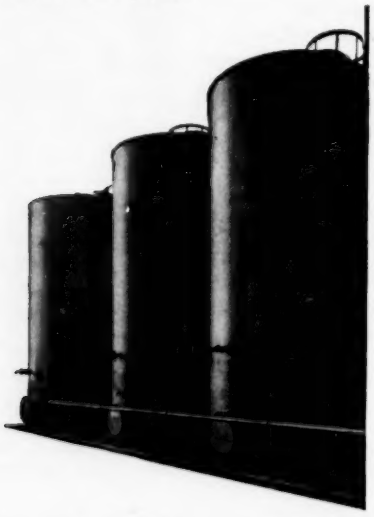
See why ALCOA ALUMINUM makes a good design habit

Requirement: A better way to store process liquids and gases
Key to Good Design: Use Alcoa Aluminum Storage Tanks

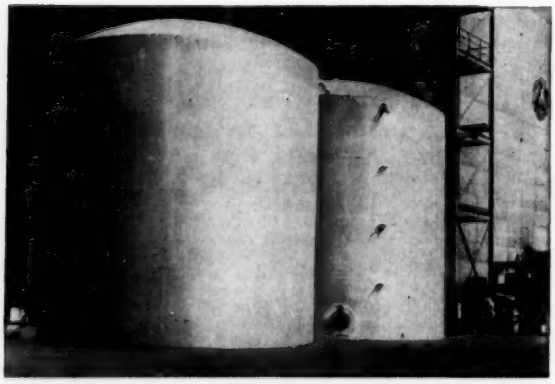
Whether product storage is an intermediate or final step in your processing operation, ALCOA® Aluminum Storage Tanks can help cut costs and maintain product purity. The production of glacial acetic acid is a prime example. For over 30 years ALCOA Aluminum tanks have been specified for storing this chemical because they resist corrosion and offer real economies in initial investment and in freedom from maintenance costs.

Thousands of aluminum tanks and tank cars have been constructed for the transport and storage of such chemicals as ammonium nitrate solutions, acrylonitrile, cryogenic substances and sour crude oils. Some of the many other products for which aluminum alloy tanks are well suited are listed below.

ALCOA can supply aluminum storage tanks for practically any processing application. They are made in a number of sizes ranging from 580 to 21,480 gal and are available in both horizontal and vertical construction.



Oleic acid is one of the many chemicals often stored in aluminum tanks. Aluminum preserves the color and purity of this product.



These aluminum storage tanks maintain the purity of steam condensate for a large public utility.

Fabricated from 3003 aluminum alloy, ALCOA Standard Storage Tanks measure 10 ft in diameter with varying lengths for different capacities. ALCOA also supplies special storage tanks to many processors. These can be furnished in intermediate lengths and capacities, and in a wide range of aluminum alloys for many process applications.

ALCOA engineers have worked closely with all segments of the process industries for over 40 years, and can help you specify the aluminum alloy storage tanks and other equipment best suited for your particular process application. ALCOA's unparalleled experience in this field is available to you for the asking. Write to the address on the coupon, stating your requirements as specifically as possible. ALCOA's development engineers will welcome the opportunity to work with you on your problems.

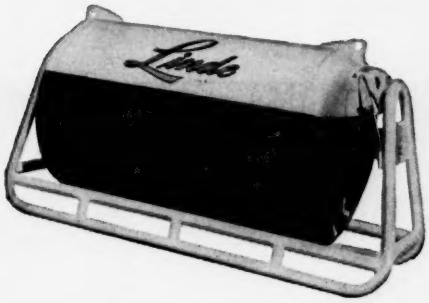
You can also take advantage of the wide selection of free ALCOA literature on aluminum for storage tanks and other process applications. Simply check the booklets you want on the coupon and mail to the address indicated. ALCOA will forward your material promptly and without obligation.

During 1959, ALCOA will conduct engineering conferences in a number of major cities on process industries applications of aluminum. Contact your nearest ALCOA sales office for full particulars and dates.

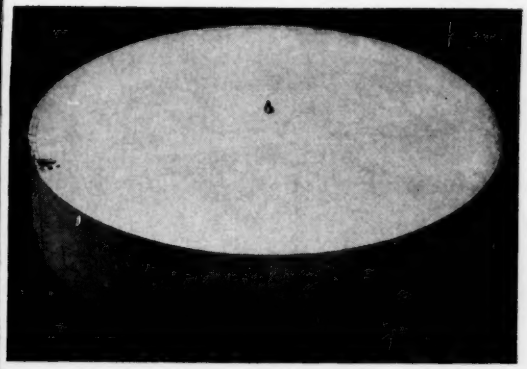
Typical chemicals stored in ALCOA tanks

Acetaldehyde	Glycerol phosphate
Acetic acid, glacial	Lacquer
Acetic anhydride	Methyl alcohol
Acetone	Napthenic acids
Acrylic acid, glacial	Naval stores
Acrylonitrile	Nitric acid (above 82% conc.)
Adipic acid	Nylon salts
Ammonium carbonate	Oleic acid
Ammonium nitrate solutions	Phenol
Ammonium thioglycolate	Propyl alcohols
Amyl mercaptan	Propylene glycol
Animal oils	Resins
Benzene	Rosin
Butyl alcohols	Sorbitol
Cellulose acetate	Solvents
Edible oils	Stearic acid
Ethyl acetate	Sugar solutions
Ethyl alcohol	Toluene
Ethylene glycol	Trichlorobenzene
Fatty acids	Turpentine
Gasoline	Water (distilled or deionized)
Glycerine (natural & synthetic)	Waxes

Fatty acids are not discolored by contact with aluminum.



Aluminum's light weight assures easy handling and storage for this 600-liter nitrogen container. The tank is fabricated from Alcoa Aluminum Alloy 5154.

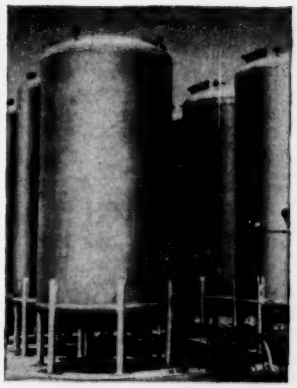


The world's largest all-aluminum tank stores 2½ million gal of ammonium nitrate at 180°F. Prime consideration here was the need for uninterrupted storage service with a minimum of maintenance. The tank stands 26 ft high, and has a diameter of 128 ft.

Typical mechanical properties of Alcoa Aluminum Alloys

Alloy and Temper	Tension			Hardness, (2)	Shear Ultimate ksi	Fatigue Endurance Limit, ksi	Modulus of Elasticity ksi
	Strength, Ultimate	ksi Yield	Elongation % in 2 in. (1)				
5052-O	28	13	25	47	18	16	10,200
5083-O	42	21	22	73	26		10,300
5086-O	38	17	22	65	23		10,300
5154-O	35	17	27	60	22	17	10,200
5454-O	36	17	22	62	23		10,200
5456-O	45	23	24	75	28		10,300

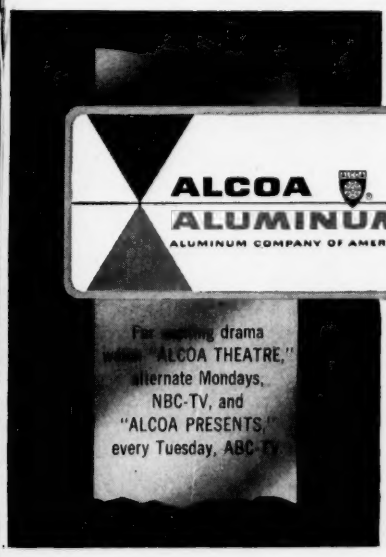
(1) 1/16-in. thick specimen
(2) Brinell; 500-kg load, 10-mm ball



ASME design stress values for various Alcoa Aluminum Alloys (psi at 100 degrees F)

5052..... 6,250 psi
5083.....10,000 psi
5086..... 8,700 psi
5154..... 7,350 psi
5456.....10,500 psi

Alcoa standard tanks are constructed of stock components and are available for fast delivery. They provide the safest storage for a wide variety of chemicals, petrochemicals and petroleum products.



Aluminum Company of America
871-K Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum for storage tanks and other uses in the process industries:

- ☐ 10387 Alcoa Standard Storage Tanks
- ☐ 10460 Process Industries Applications of Alcoa Aluminum
- ☐ 10508 Cleaning and Maintenance
- ☐ 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
- ☐ 20265 Have You Tried Aluminum in Your Refinery?
- ☐ GL93 Aluminum in the Pulp and Paper Industry
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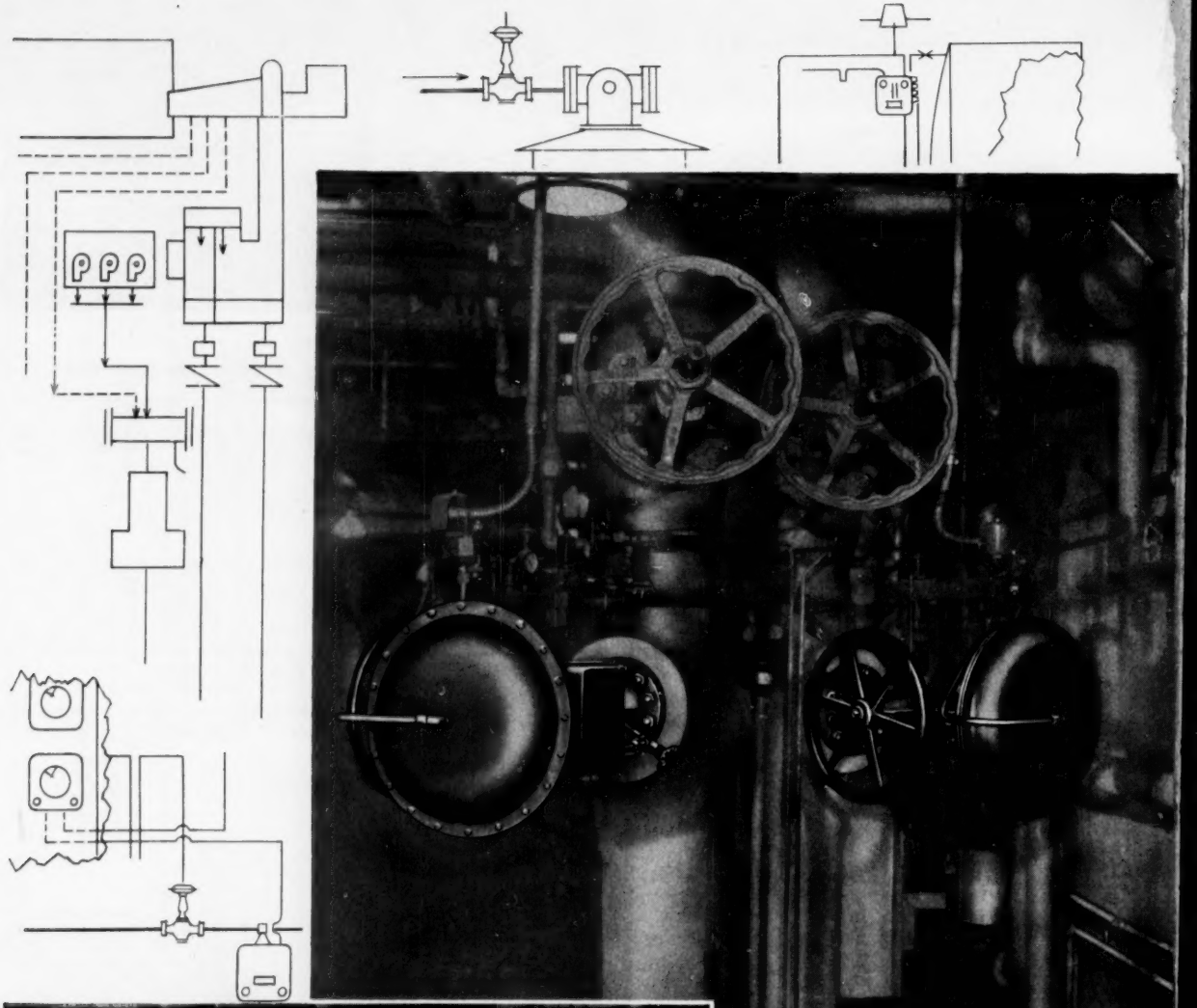

Boiler Feed Water Control Valves installed at the Shippingport, Pa. Atomic Power Plant.

Control Valves for Turbine Driven Boiler Feed Pumps

VERSATILITY OF STANDARD MASONEILAN CONTROLS

Key to Dependability and Economy in Power Plant Operation

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CONTROL VALVES . . . body and trim types are designed to permit a maximum of interchangeability; full or reduced capacity; with percentage or linear characteristics as required. Advanced design butterfly types are also available with wide choice of actuators, and soft and angle seating.

LEVEL CONTROLLERS . . . units for proportional, proportional-reset, differential-gap control, or for pneumatic transmission, or combinations of any two of these in a single case. Also a complete variety of vessel mounting types.

PNEUMATIC CONTROLLERS . . . non-indicating, indicating and recording instruments for controlling pressure, temperature and flow. Features include unit sub-assemblies for wide choice of function and variety of action.

TRANSMITTERS . . . for pressure, temperature, flow and level, providing accurate remote measurement and pneumatic transmission; featuring a number of exclusive advantages.

Versatility designed into standard Masoneilan products helps to achieve accurate, dependable control with simplicity and economy. It can be profitable to you.

For details call a Mason-Neilan representative, or write:

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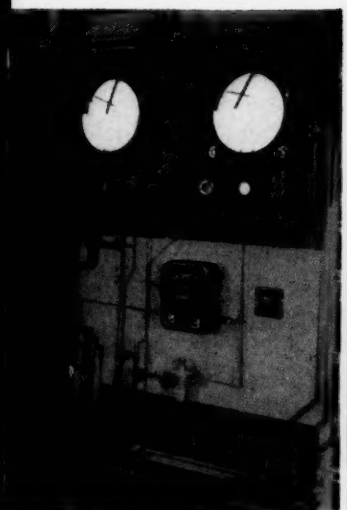
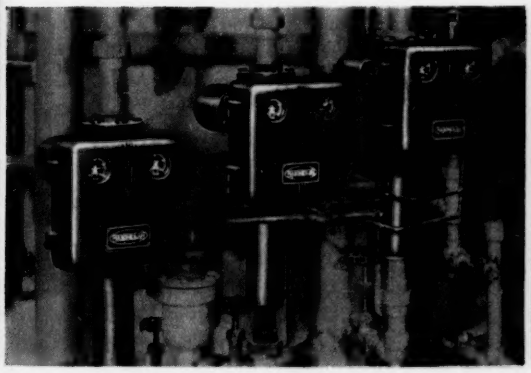
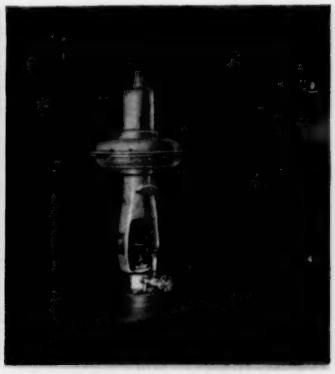


Pressure and Temperature Controllers



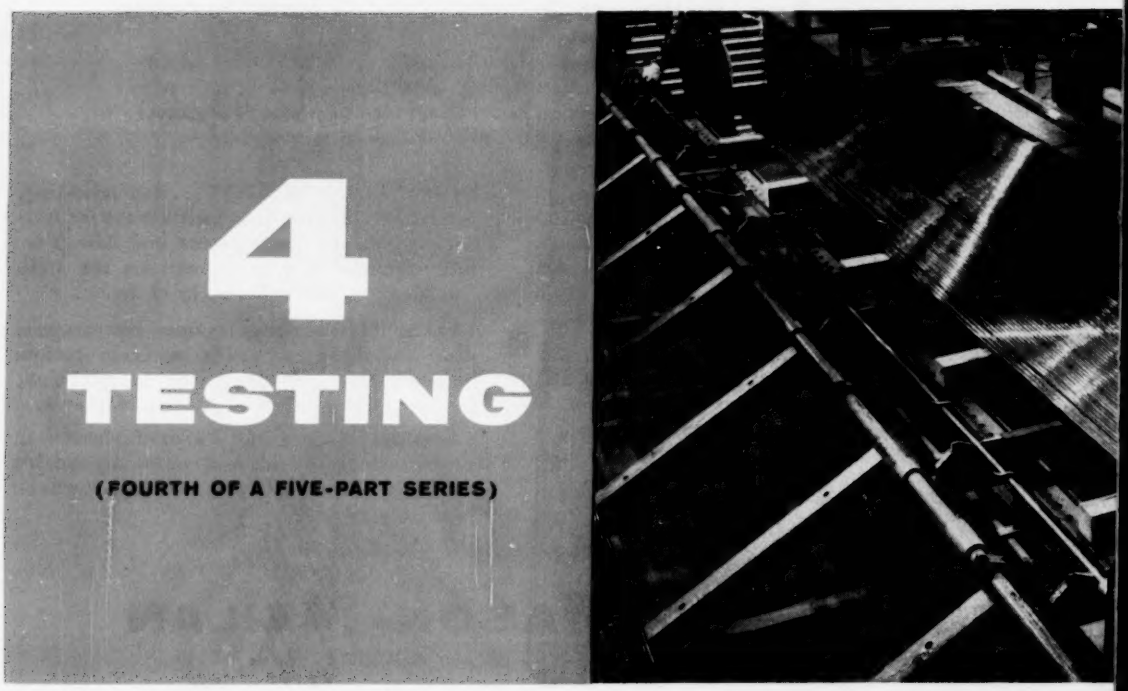
Level Controllers on Condenser Hotwell



Control Valve in Feedwater Starting Service

MNB-31

How lasting quality is Heat Exchanger



The quality of Phelps Dodge heat exchanger and condenser tubes is continually controlled at every stage of the entire fabricating operation by a special "in-mill" laboratory. In addition, the finished tubes are given exhaustive physical, chemical and metallurgical tests to assure quality and conformance with specifications.

All physical tests, including hydrostatic, flattening and expansion tests, are performed in strict accordance with ASTM and customer specifications. In the chemical laboratory, samples of the tubes are analyzed both chemically and spectrographically to determine the exact composition and conformance to the specifications. Experienced metallurgists minutely examine the grain structure of the metal in samples of both "in-process" and finished tubes. The grain size and temper are also carefully determined.

Throughout the entire tube fabricating operation—from raw materials to finished product—quality is the keynote. That's why Phelps Dodge tubes are preferred by those who demand the finest . . . the manufacturers and users of heat exchangers and condensers.

built into Phelps Dodge and Condenser Tubes...

Finished tubes receive the hydrostatic test, a quality control check in which water is pumped into the tubes at high pressures.

Another quality control test is this multi-frequency eddy current device which helps assure flawless tubes.

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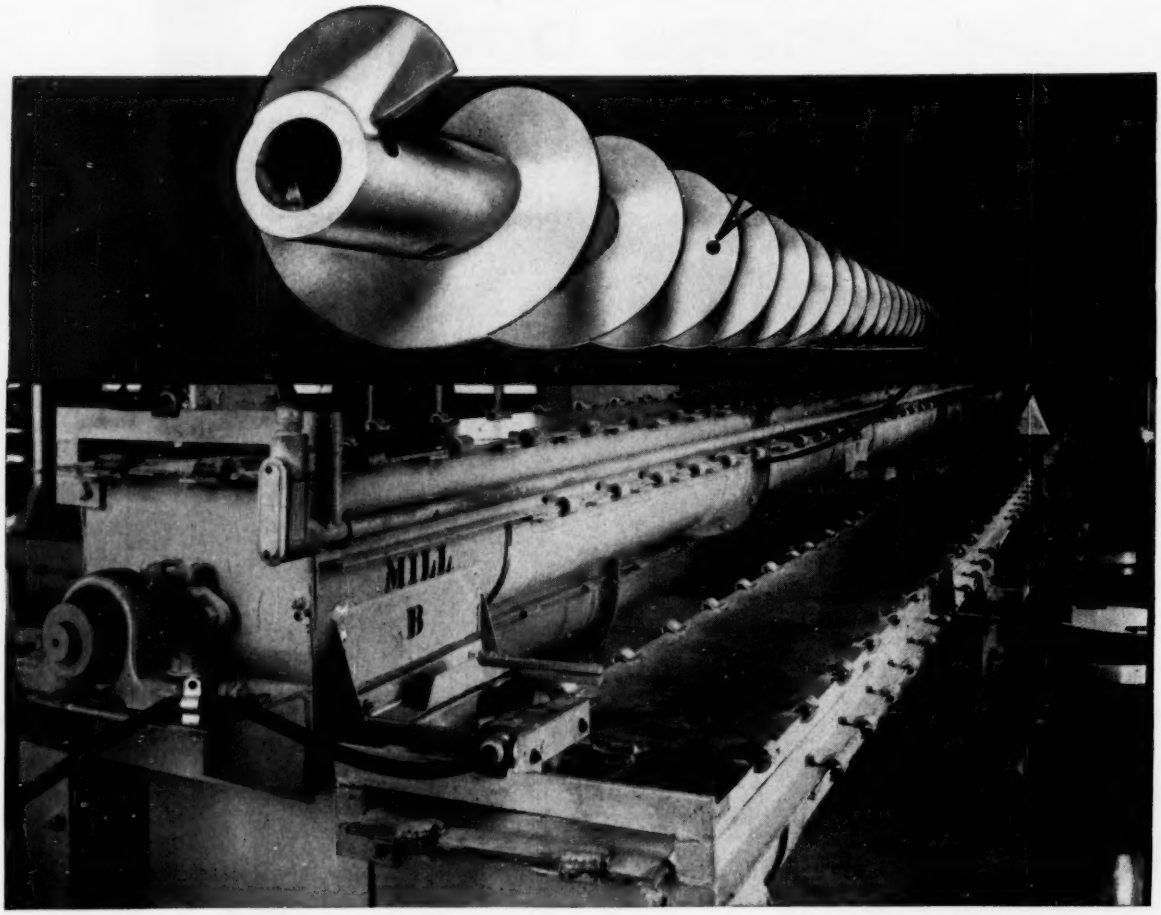
Why a system of LINK-BELT screw conveyors

FITS LIKE A GLOVE AND WORKS LIKE A CHARM



- **Thorough engineering analysis of all conditions**
- **Full responsibility for satisfactory performance**
- **Unbiased selection from industry's most complete range of components**
- **Expert field erection**

With Link-Belt, screw conveyor engineering includes far more than just supplying a suitable product. All related aspects of your production are considered—including prior and subsequent handling, plus integration with other equipment. And because Link-Belt handles all details from specification to erection, it means a better-working system with less work for you.

Continuous product improvement and development by Link-Belt has produced industry's widest range of components for screw conveyor applications—various types of flighting, gates, troughs, drives . . . plus a new line of ball and roller bearing equipped accessories.

Link-Belt specialists will work with you to determine the feasibility of adapting screw conveyors to your operation. Call or write your nearest Link-Belt office for full details. Ask for Book 2989.

LINK-BELT

SCREW CONVEYORS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,234

LIGHT...STRONG...SAFE...ECONOMICAL
Hackney Cylinders are "right" for any gas

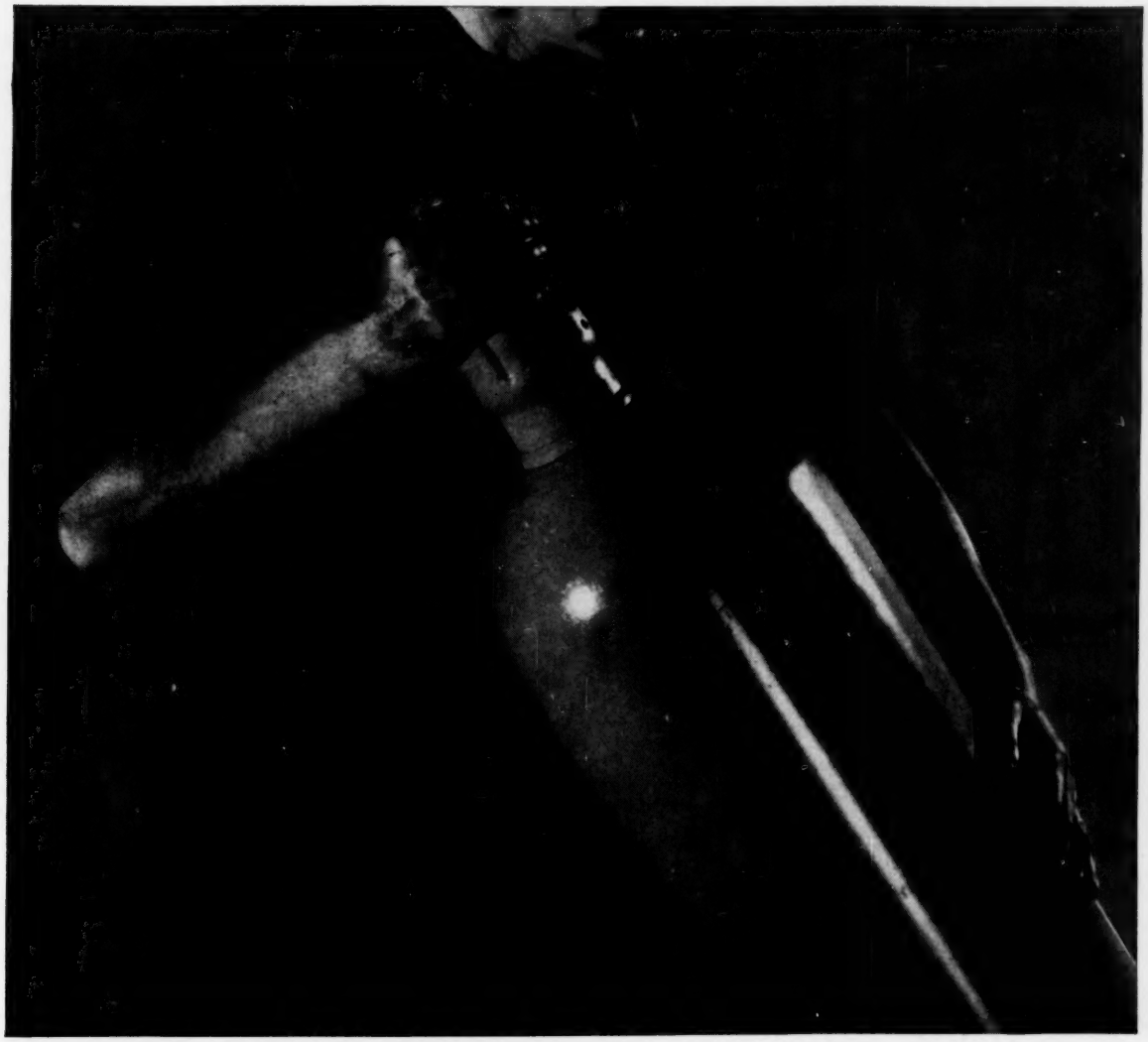
You name the gas—there's a Hackney high-quality cylinder for it in the capacity you want...the quantity you need!

Hackney seamless or welded cylinders are made in all shapes and sizes for all services—from small medical flasks to 220's and 300's (cu. ft.)—for oxygen, nitrogen, hydrogen, helium, cyclopropane, argon, carbon dioxide, ethylene, liquid chlorine, anhydrous ammonia, refrigerant gases, etc.

Hackney cylinders, for either high- or low-pressure service, offer many advantages: light weight... maximum strength...uniform cylinder capacity... smooth surfaces...super-clean interiors...maximum safety—exceed all ICC requirements.

As a result, you save money on shipping costs... reduce handling charges...cut maintenance costs... speed filling operations...amortize your cylinder investment over shorter periods of time—and the smooth attractiveness of your painted cylinders makes your service welcome everywhere.

For complete facts and prices of Hackney high- or low-pressure cylinders, write to the address below.



Pressed Steel Tank Company

Manufacturer of Hackney Products

1447 South 66th Street, Milwaukee 14, Wisconsin

Branch offices in all principal cities

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

For Maximum Resistance to HARBISON-

for every petroleum refining

H-W CASTABLE REFRACTORIES

They comprise all commercial classes. Proper brand selection provides the best combination of physical and chemical properties for specific applications—assuring maximum life and economy. Installation may be by various methods —gunning, trowelling, pouring or tamping—depending upon composition and application.

H-W CASTOLAST

This extremely high-purity, low-iron castable consists of accurately grain-sized tabular alumina and low-iron calcium-aluminate binder. It develops high strength throughout its temperature range, is unaffected by reducing atmospheres, and is very abrasion resistant. It is excellent for lining catalytic vessels, butadiene reactors, feed lines and cyclones.

H-W HARCHROME

This extra strength chrome-base castable with hydraulic binder takes an extremely hard, strong set. It is especially designed for maximum wear resistance in feed lines and cyclones of catalytic cracking units.

H-W EXTRA STRENGTH CASTABLE

A blended mixture of carefully sized hard-fired refractory aggregates, bonds and hydraulic binders, this product is strongest of all regular fireclay castables. It is highly recommended for regenerator and reactor linings, catalyst feed lines, cyclones, doors and sub-bottoms of various types of furnaces, and patching worn brickwork.

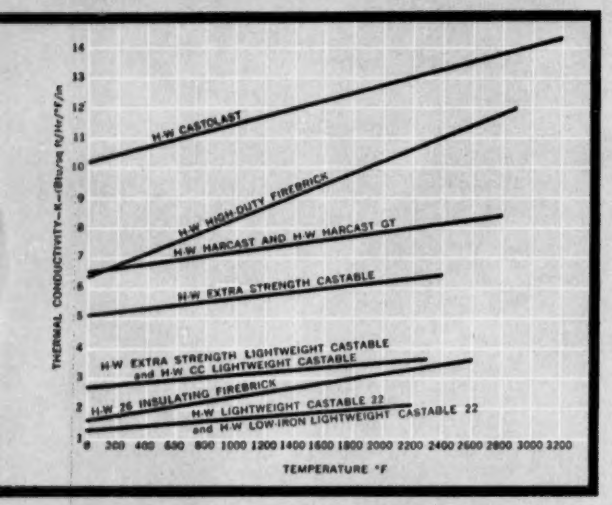
H-W HARCAST AND H-W HARCAST GT

These castables are manufactured from super-duty calcined fireclay carefully combined with high-purity plasticizers and hydraulic binders. The iron content in each is less than 1%, which adequately meets the specifications of petroleum companies. They are used where platinum catalysts are employed and provide exceptional strength at all temperatures up to their service limits.

H-W LIGHTWEIGHT CASTABLE 22

(Former brand name—H-W 56 Lightweight Castable)

A quality-controlled mixture of lightweight aggregates and hydraulic binders, it combines light weight and strength to utmost degree, has very low thermal conductivity and serves as an ideal insulation behind hard surface abrasion-resistant castables or brick. It gives outstanding service in regenerators and reactor linings, ducts and breechings, boiler wall backing and tube decks, air preheater linings, heater walls, roofs and door linings.


THERMAL CONDUCTIVITY—K=(Btu/sq ft/Hr/°F/in
H-W CASTOLAST
H-W HIGH-DUTY FIREBRICK
H-W HARCAST AND H-W HARCAST GT
H-W EXTRA STRENGTH CASTABLE
H-W EXTRA STRENGTH LIGHTWEIGHT CASTABLE and H-W CC LIGHTWEIGHT CASTABLE
H-W 26 INSULATING FIREBRICK
H-W LIGHTWEIGHT CASTABLE 22 and H-W LOW-IRON LIGHTWEIGHT CASTABLE 22
TEMPERATURE °F

This Useful Chart—indicating service limits and comparative thermal conductivities (along with a table of physical properties)—is included in a newly-published brochure, "Harbison-Walker Refractories for the Petroleum Refining and Petrochemical Industries."

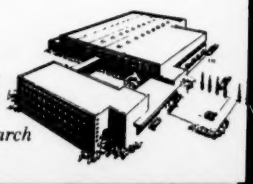
HARBISON-WALKER REFRACTORIES COMPANY

AND SUBSIDIARIES

GENERAL OFFICES: PITTSBURGH 22, PA.

World's Most Complete Refractories Service

Leadership in refractories through constant research



The Garber Research Center

Corrosion, Abrasion, Reducing Atmospheres . . .

WALKER REFRACTORIES

and petrochemical application

H-W LOW-IRON LIGHTWEIGHT CASTABLE 22

(Former brand name—H-W 56 Low-Iron Lightweight Castable)

Manufactured from low-iron lightweight aggregates and high purity calcium-aluminate binders, it is especially designed for oil refinery units operating in hydrogen and other reducing atmospheres.

H-W EXTRA STRENGTH LIGHTWEIGHT CASTABLE

(Former brand name—H-W 85 Lightweight Castable)

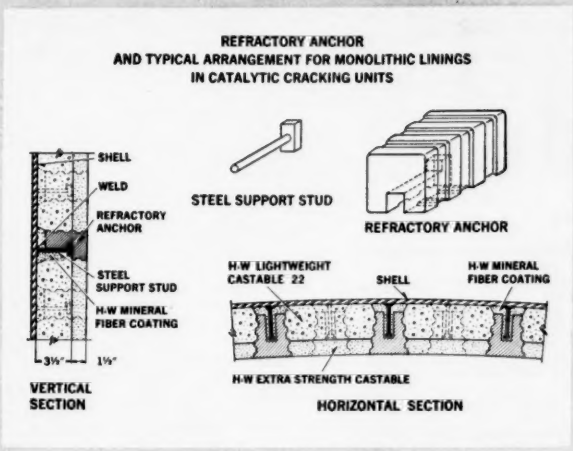
Consisting of carefully selected and sized lightweight aggregates and hydraulic setting binders, it has combined properties of light weight, high strength, low heat conductivity and desirable refractoriness. It is used for lining ducts and breechings, boiler wall backing and tube decks, furnace walls, roofs and doors.

H-W CC LIGHTWEIGHT CASTABLE

This combination of best selected and sized lightweight aggregates and hydraulic setting binders was especially developed for "one-shot" linings in catalytic cracking units.

IMPROVED ANCHORING METHOD

Supplementary to the conventional anchoring methods, the design of the refractory anchor installation shown here is particularly suitable for certain specific uses such as regenerators and reactor linings.



H-W REFRACTORY BRICK AND SHAPES

All classes of fireclay brick, high-alumina brick, silica brick, basic brick and acid-proof brick and tile are available for petroleum and petrochemical needs.

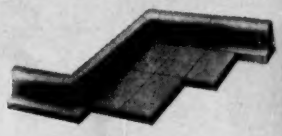
ALAMO AND VARNON

These brands possess chemical and physical properties which make them especially suited for the diversified operating conditions of refinery and petrochemical processes. Enhanced by high temperature heat treatment, VARNON has a high degree of immunity to damaging effects of carbon monoxide and hydrocarbon gases at critical temperatures.

A Typical Duro Tower Packing Ring
Ring No. 403 6" x 6"

H-W MULLITE—KORUNDAL—H-W CORUNDUM

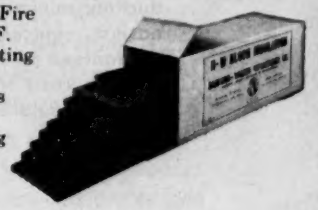
These high-alumina refractories are noted for unusual stability under severe temperature conditions, and excellent resistance to fluxing by corrosive slags and fumes, such as volatile alkalies and vanadium oxide present in the ash of some oils.



Duro Acid-proof Floor Tile

H-W INSULATING REFRACTORIES

All Classes of Insulating Fire Brick—1600°F. to 3000°F.
Mortars for Laying Insulating Brick
H-W Lightweight Castables
H-W Block Insulation
H-W Mineral Fiber Coating
H-W Finishing Cement



New Brochure

describes complete line of refractories for petroleum refining and petrochemical applications including all classes of castables, brick and shapes, insulating firebrick, block insulation, mineral fiber coating, finishing cement, and bonding mortars.

Send today for your personal copy

Harbison-Walker Refractories Company
Farmers Bank Building, Pittsburgh 22, Pennsylvania

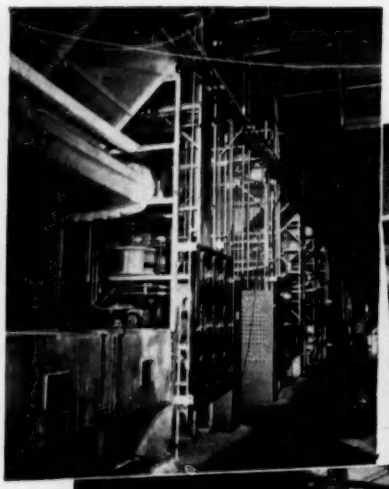
☐ Please send me a copy of your new brochure, *Harbison-Walker Refractories for the Petroleum Refining and Petrochemical Industries.*

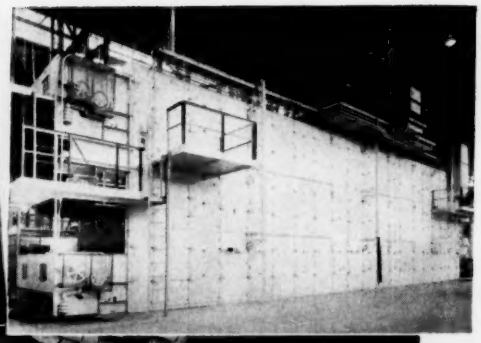
NAME_____

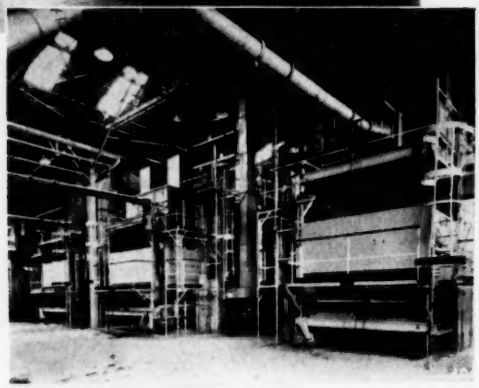
COMPANY_____

TITLE_____

ADDRESS_____







DRYERS *by* SARGENT Lead The Field

. . . in operating economy; proven high-level production; minimum of maintenance requirements; easiest, quickest cleanout; dependability of guaranteed performance; fastest installation with erection costs the lowest on the market. Let us give you details.

DRYERS (Conveyer, Tray, Truck, Pole, Tunnel, Laboratory, Pilot Plant)
COOLERS • FEEDERS • EXTRUDERS • GRANULATORS

C. G. SARGENT'S SONS CORPORATION

Graniteville, SINCE 1852 Massachusetts

PHILADELPHIA • CINCINNATI • ATLANTA • CHARLOTTE • HOUSTON • CHICAGO • DETROIT • TORONTO

Shown above are some installations of Sargent Dryers at work in one division of the chemical process industries — Synthetic Rubber. Pictured clockwise are:

BALE DRYER — A completely new design developed in cooperation with the company's engineers. Steel frame. Aluminum panels. Gas-fired. High quality production. United Rubber and Chemical Company, Baytown, Texas.

BANK OF FOUR SYNTHETIC RUBBER DRYERS — Each is 3-pass, gas-fired, with coolers an integral part of the machine. Goodyear Tire and Rubber Company, Houston, Texas.

PILOT PLANT DRYER WITH EXTRUDER and Cooling Section — Remarkably compact and efficient. Each section with individual motor and fan. Uses 1.2 lbs. of steam to each pound of moisture removed. A widely-known chemical company.

3-PASS GAS-FIRED DRYER — believed to be the largest such machine ever built. Note hinged, full height doors for complete accessibility to entire interior. Uses only two gas burners for heat source, with working temperature attained in less than 10 minutes from startup. Polymer Corporation Limited, Sarnia, Canada.

DRYER AND COOLER — High volume production. Crumb leaves cooler (in-built as part of the machine) ready to bale. Has special Sargent-designed breaker to keep crumb flowing freely. Many other exclusive features. A large rubber and chemical company.

FOUR SARGENT DRYERS for England's first general purpose (bulk) synthetic rubber plant. Built under Sargent license by L. A. Mitchell & Co., Manchester, England. International Synthetic Rubber Company Ltd., Hythe, Southampton.

A "UNIVERSITY" OF NEW IDEAS

Here is the most practical "school of learning" for anyone concerned with management, design, research and development or production in the process industries. Here, at the Exposition of Chemical Industries, you will get a concentrated "course" in What's New—and how it can be put to work for you.

In five short days you can see and compare the newest product developments of over 500 leading manufacturers—all under one roof. Here you can learn about new ideas for cutting costs, improving your product and increasing production. In no other way can you see so much or learn so much that will be helpful to you in your business.

Make your plans to attend. See next page.

SEE THESE NEW PRODUCTS AT THE

27th EXPOSITION OF CHEMICAL INDUSTRIES

Abrasives
Absorbers
Acids
Acidifiers
Acid Resisting Materials
Adhesives
Agitators
Air Conditioning Apparatus
Alkalies
Alloys
Analyzers
Asbestos
Autoclaves
Bags
Balances and Weights
Barrels, Drums & Kegs
Blowers
Bottling Machinery
Brick, Acid Proof
Briquetting and Tablet Making Machinery
Buckets, Elevator
Burners
Calciners
Calorimeters
Cans
Carbon
Castings
Catalysts
Cement
Centrifugals
Ceramics
Chemical Stoneware, Acid Proof
Chemicals, Industrial
Chemicals, Laboratory
Chemicals, Pharmaceutical
Chlorinators
Clarifiers
Classifiers
Coal Tar Oils
Coatings—Protective
Collectors
Colloid Mills
Colorimeters
Comparators
Compressors
Concentrators
Condensers
Containers
Control Apparatus
Controllers
Conveying Machinery and Equipment
Coolers
Cooperage
Crucibles
Crushers, Grinding Mills and Pulverizers
Crystallizing Equipment
Cylinders for High Pressure Gases
CO_2 Recorders
Decolorization and Purifying Materials
Digesters
Dissolvers
Distilling Machinery and Apparatus
Drums, Rotary, Vacuum
Drying Machinery and Equipment
Dust & Fume Collecting Systems
Dust and Spray Masks
Ejectors
Elevators
Emulsifiers
Emulsions
Evaporators
Exhausters
Extraction Plants
Extractors
Fans
Feeders
Fillers
Filling Machines
Filter Aids
Filter Cloth
Filter Paper
Filters
Fittings
Furnaces and Accessories
Gages
Gases
Glass—Optical
Glassware
Grating
Grinders
Heat Exchangers
Heaters and Heating Equipment
Homogenizers
Hoods, Fume
Indicators
Instruments, Optical
Instruments of Precision
Instruments, Testing
Insulating Material—Heating, Electric and Molded
Insulation, Furnace
Joints, Flexible
Kettles
Kilns
Labeling Machines
Laboratories, Testing
Laboratory Apparatus and Supplies
Laboratory Furniture
Lead Burning and Coating
Magnetic Separators
Masticators
Material Handling Equipment
Metal Coating and Plating
Metal Containers
Metals
Meters
Microscopes
Mills
Minerals
Mixing and Kneading Machinery
Molding Machinery
Motors, Electric
Naval Stores
Nitrators
Nozzles, Spray
Nuclear Products
Ovens
Packaging Equipment and Supplies
Packing
pH Equipment
Pipe and Fittings
Plastics
Plasticizers
Platinum—Wire, Sheet, Foil, Crucibles, Laboratory Ware
Pressure Relief and Rupture Relief Devices
Pulverizers
Pumps
Pyrometers
Recording Instruments
Rectifiers
Refractories
Refrigerating Equipment
Regulators, Pressure and Temperature
Resins and Oils
Respirators
Rotameters
Rubber Products and Equipment
Safety Equipment
Scales
Screens—Inclined, Vibrating, Gyratory
Sealing Machines
Separators
Sieves, Laboratory
Sifters
Sinks, Laboratory, Acid Proof
Sizers
Solvent Recovery Equipment
Solvents
Spectrographs
Spectrometers
Speed Reducers
Spray Drying Systems
Steel Grating and Flooring
Sterilizers
Stills
Strainers
Switches
Tachometers
Tanks
Thermometers
Thickening and Dewatering Machinery
Tower Packing or Filling
Towers
Traps, Steam
Tubes
Tubing
Turbines
Valves and Fittings
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Waterproofing Compounds
Water-Conditioning Equipment
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Welding Equipment
Wire Cloth
X-Ray Equipment

OVER 500 EXHIBITS

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NEW PRODUCTS
NEW COST-SAVING IDEAS

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NEW AND BETTER WAYS TO INCREASE PRODUCTION

Plan now to see actual demonstrations of the newest developments in products such as those listed above. Bring your associates and actually see how these products can be used to advantage in your plant. You'll learn a lot from the fact-filled displays that will fill the Coliseum to capacity. Fill in and mail the coupon now. You will be well repaid for the modest investment in time. Act now!

Management: International Exposition Company

27th EXPOSITION OF CHEMICAL INDUSTRIES
480 Lexington Avenue, New York 17, N. Y.

Please register me in advance and send admission badge

Name_____ Position_____

Company_____

Street_____

City_____ Zone_____ State_____

Products made or type of business_____

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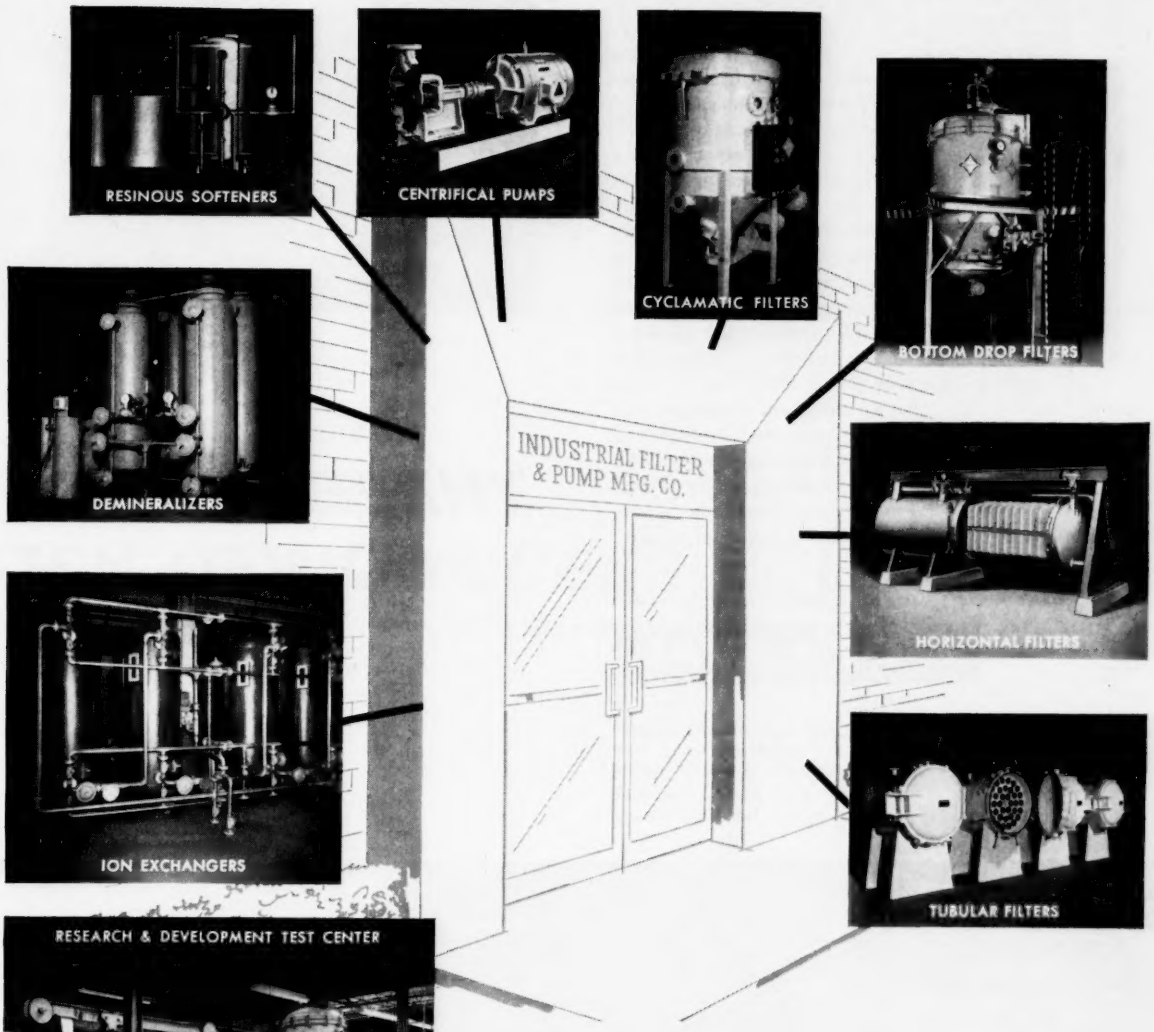
FREE *Advance Registration*

Fill in and mail this card NOW! No further registration necessary. Your badge will be mailed to you and will admit you to the EXPOSITION as many times as desired. Badge is not transferable.

INDUSTRIAL ENGINEERED EQUIPMENT

for liquid Clarification · Recovery · Treatment



COMPATABILITY of the filtering equipment with the filtering job is the reason why operators rely on *Industrial* for low-cost destruction of toxic waste, or for clarification, recovery or treatment within the system.

Why not investigate Industrial's *Engineering Survey Service?* . . . for a thorough appraisal of your needs by qualified chemists and engineers. Write for details and . . .

See our advertisement PP1263—1268 in the 1958-59 *Chemical Engineering Catalog.*

INDUSTRIAL

C 259

INDUSTRIAL FILTER & PUMP MFG. CO.

5918 Ogden Ave., Cicero 50, ILLINOIS

Fred Wheelwright, Manager, Industrial Sales: "One of the most pressing problems in industry today is upgrading processing efficiency. It's one of our specialties here at De Laval, and we go at it with a triple punch: outstanding engineering staff, the most complete processing pilot plant in the country, and a full line of outstanding process equipment.

"There are cases where it is relatively easy . . . replacing more traditional processing methods with modern, high speed and high capacity process equipment. Sometimes, it's only a part of the process that needs improving; in other cases, our engineering staff has developed a whole new system (De Laval's patented Tall Oil Process is a case in point.)

"But whatever the problem . . . in heating or cooling, separation or recovery . . . we've found that we can almost always increase processing efficiency through careful selection of exactly the right process equipment. Why not let us work on your processing problems? Just drop us a line about them on your letterhead. No obligation, of course."

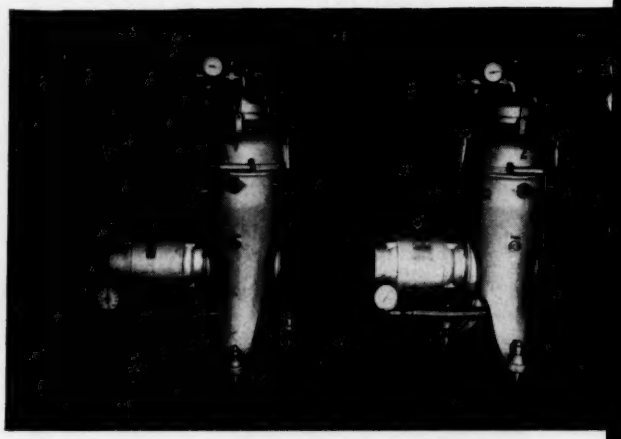
For further information, write to De Laval.

DE LAVAL

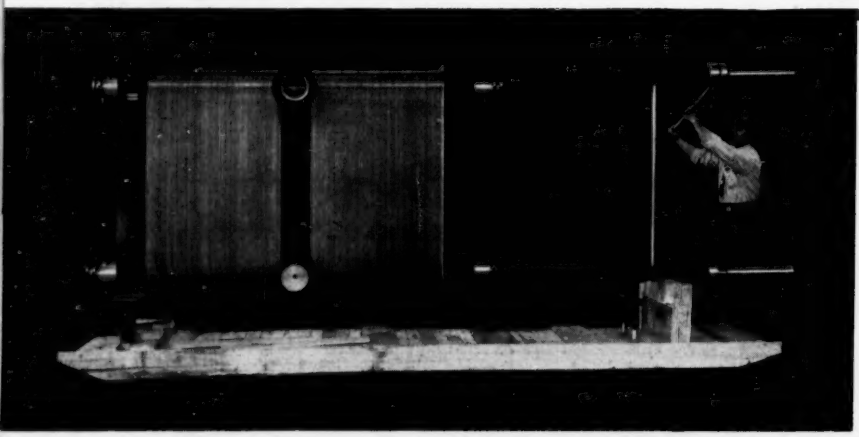
Dept. C-10

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
5724 N. Pulaski, Chicago 46, Illinois

DE LAVAL PACIFIC COMPANY
201 E. Millbrae Avenue, Millbrae, California



THREE CRITICAL SOLVED WITH



LATEX PROCESSOR HAD A STICKY PROBLEM WITH A HOT SOLUTION

Problem: To heat a solution of 45% Latex concentration from 117°F to 170°F without precipitating excessive coagulum.

Solution: De Laval Plate Heat Exchanger. Shell & Tube exchangers could not be used; they'd be impossible to clean. Instead, this company installed a two section De Laval Plate Heat Exchanger, each section handling 114,500 pounds per hour of the latex concentration. With Type 316 stainless steel plates and a total heat transfer surface of 1,090 sq. feet, the unit has been in operation (and operating perfectly) for almost two years.

Even in processing of a solution as sticky as latex, the De Laval Plate Heat Exchanger is cleaned *in place* by circulation of a cleaning solution immediately following the heating of the latex. For periodic cleaning other than by circulation, the plate pack is easily opened. All heat transfer surfaces are immediately exposed for manual cleaning with a minimum of trouble.

HOW PILOT TESTS LICKED CORROSION PROBLEMS IN EPOXY RESIN PROCESSING

Problem: In extracting epoxy resin from vegetable oil, our customer needed equipment that would successfully separate the resin from the highly corrosive reaction mixture and do so without aeration.

Solution: De Laval Model S-194 Hermetic Centrifuges. Like all answers, this one seems easy after it is known. But in order to determine exactly what equipment would satisfy our customer's needs, we ran extensive tests in our full scale pilot plant. As a result of the pilot operations, two S-194 Hermetic centrifuges were installed, each operating at a capacity of 1000 gph. All parts coming in contact with the corrosive liquid are of Type 316 stainless steel.

These machines have been in full scale, successful operation for better than two years; since then, there has been no problem whatsoever with corrosion, aeration, or any other aspect of the process.

When you're developing a new process, or adapting an existing process, remember that De Laval's engineering staff and full scale pilot plant are at your service to help you determine the most efficient, highest capacity processing equipment for your own specialized needs.

PROBLEMS...
DE LAVAL PROCESS EQUIPMENT

CENTRIFUGES • PLATE HEAT EXCHANGERS • VIBRATING SCREENS • COMPLETE PROCESSES

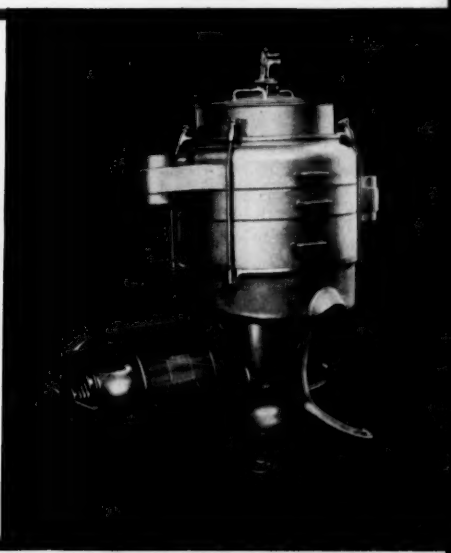
GETTING RID OF THE BUGS IN ANTIBIOTICS PROCESSING

During World War II, our customer had installed a battery of all-stainless centrifuges for production of antibiotics. They had been in full scale operation ever since.

Problem: After fifteen years with the original machines, the processor felt the need for greater processing efficiency, higher capacities, and the elimination of shut-down for manual cleaning of the centrifuge bowls.

Solution: The De Laval AC-VO-3 "Nozzle-Matic." One of these machines replaces three of the earlier centrifuges, running five days per week (24-hours per day) on a non-stop production basis. Since the bowl is equipped with nozzles built right into the bowl wall, solids are discharged continuously while the machine is operating at full speed. Liquid effluent is discharged from its own outlet, and the machine need never be stopped for manual cleaning.

What about your own processing operation? If you could benefit from greater efficiency and higher capacities, it might well pay you to investigate updating your process with De Laval Process Equipment.



DOW | **CHEMICAL BUYERS GET A BONUS**

The sale of a drum—or a tank car—of processing chemicals can mean many things. At Dow, what's *outside* the drum or tank car is considered of equal importance with what's inside. Buyers of Dow chemicals always get dependable, uniform product inside . . . and a bonus outside in the form of assurance of adequate future supply, as well as prompt, economical delivery and specialized Dow technical service.

You may wish to check certain items in this advertisement and forward to those concerned in your company.

ROUTE TO:

_____

_____

_____

_____

_____

NEW CENSUS REVEALS BURGEONING POLYOL POPULATION

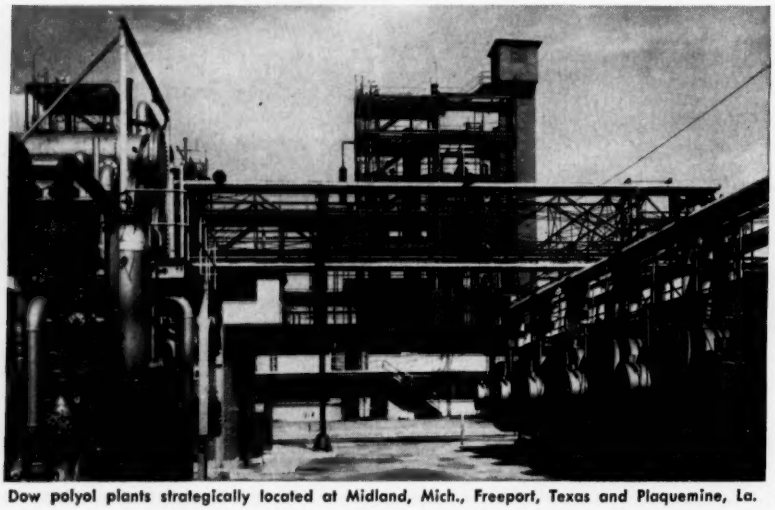
"The men that make the most of them" report plenty of polyols, abundant supplies in the foreseeable future, experienced polyol specialists ready to help Dow customers select and adapt products for their needs . . .

"If we can't help a customer find the right polyol from our line-up", comments a Dow research chemist, "it's probably because a polyol is not the answer to his request!" Polyol specialists at Dow recently paused in their full-time job of matching polyols to specific problems long enough to count polyol noses. When all the returns were in, the grand total showed Dow now offers hundreds of different polyol products!

This figure certainly supports Dow's claim to "the world's widest line". There is, of course, another facet to Dow's position in the polyol business that is just as important, though less easily measured.

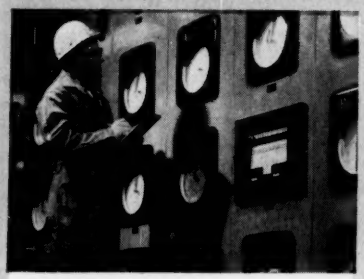
It is that Dow is BASIC in polyols. Dow is its own supplier for all of the ingredients that go into its polyols, and all the ingredients that go into the ingredients. Thus, the production of Dow polyols is closely controlled, right from ethylene and propylene. The end result is invariably highest quality, purity and uniformity.

This complete control of all raw materials is also significant because all factors of availability and basic supply are in Dow's hands. This means that Dow customers can rely on plentiful quantities at all times. Last, but far from least, is the reservoir of experience and technical know-how Dow has built up over a wide area of polyol chemistry. This deep background is readily available, in the form of extensive production and research facilities,



Dow polyol plants strategically located at Midland, Mich., Freeport, Texas and Plaquemine, La.

Attractive



DOWTHERM® A

This organic liquid serves as a heat-transfer medium with fraction-of-a-degree temperature control in the 350°-750°F. range. Less fire hazard, far less pressure than with steam systems!

as well as a crack team of polyol specialists.

Glycerine is an excellent example of the way in which Dow's polyol research benefits the chemical processing industry. Innovations in manufacturing technique have recently led to an improved quality in synthetic glycerine. To meet increasing demands for this versatile polyol, Dow's big Freeport plant produces abundant supplies of glycerine in three fine grades — synthetic, USP and USP 99.5%.

Another major branch of the family, the propylene polyols, also benefits from abundant Dow production capacity. Dow plants located at Plaquemine, La., Freeport, Texas, and Midland, Michigan, produce oxides, starting point for quality glycol products. These chemicals have no peers for purity. In fact, Dow produces a propylene glycol that qualifies for USP grade!

Ethylene polyols are further proof of the same pudding. Dow is a leading producer of caustic and chlorine, two of the ingredients Dow uses to make ethylene oxide by the chlorohydrin process. The other ingredient is also "captive" — Dow maintains cracking plants for the express purpose of producing ethylene. Dow quality-control watchdogs scrutinize the production of EO derivatives, the ethylene glycols and the polyethylene glycols. Six modern Dow bulk terminals put every plant in the U. S. on the main polyol supply line.

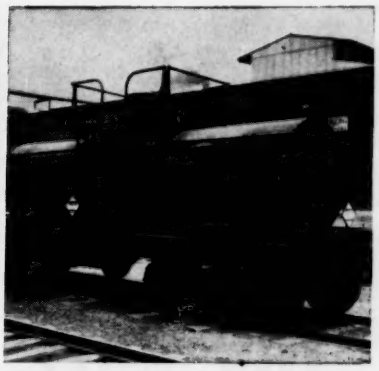
★ ★ ★ ★

CHEMICAL PROCESSING NEWS is constantly in the making at Dow. If you'd like more information on any of the products discussed in this advertisement or on any other Dow chemicals, contact the Dow sales office near you or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Chemicals Merchandising Department 99OAK10-5.

IMPROVED SPECS
for versatile solvents

There's plenty of news about Dowanol® glycol ether solvents, and it's all good! Dow's continuing product research has enabled it to tighten the reins on production of Dowanol and upgraded specifications a full notch. This means higher quality and greater purity in every Dowanol solvent . . . and in products which utilize them.

Miscibility in water and a wide range of organic materials is the outstanding characteristic of Dowanol solvents. Already proved in such applications as brake fluids, lacquers, cosmetics, paints and varnishes, these versatile chemicals invite consideration when new products are in the development stage.



BROMINE
first and foremost for 60 years

Bromine was one of the first Dow products, and today Dow is its foremost producer. Dow continues as a leading supplier and provides a host of brominated products. Six decades of bromine experience have built a backlog of information on the subject. Dow offers technical and developmental services on bromine and its derivatives second to none.

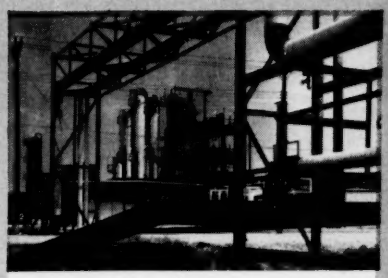
Because of this dominant position in the field, Dow can frequently tailor or upgrade bromine less expensively than customers can do it themselves. These savings, of course, benefit Dow customers. A good motto for chemical buyers to adopt is "If it involves bromine—consult Dow first."

DOW CHEMICALS *basic to the chemical processing industry*

Alkylene Oxides • Glycols • Industrial Preservatives • Polyalkylene Glycols • Glycol Ethers • Alkalies • Phenolic Compounds • Inorganic Acids • Brominated and Chlorinated Aliphatic Compounds • Halogens • Organic Acids and Esters • Inorganic Chlorides • Bromides and Bromates • Nitrogen Compounds • Salicylates • Phenyl Phosphates • Heat-Transfer Media • Flotation and Flocculating Agents • Chelating Agents • Ion Exchange Resins • Methylcellulose • Magnesium • Plastics • Aromatics

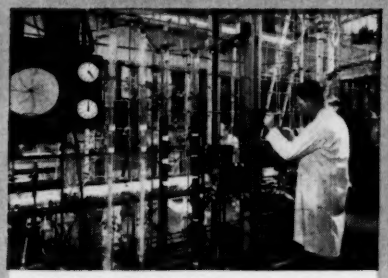
THE DOW CHEMICAL COMPANY, Midland, Michigan DOW

offerings on the chemicals counter



GLYCERINE

Expanded production facilities at Dow's huge Freeport, Texas, installation furnishing uninterrupted supply of three grades, synthetic, USP and USP 99.5%—all of unexcelled purity.



ION EXCHANGE RESINS

Dowex® resins are far and away industry's most profitable traders. They offer feasible solutions to complex separations, recovery problems and many other tough tasks in chemical plants.

ETHANOLAMINES

Crystal clear and pure . . . Dow ethanolamines improve cosmetics, shampoos, waxes and liquid buffing compounds, help eliminate gas sweetening problems for natural gas producers.

*ElectriK Tel-O-Set** control system—

the only true two-wire system

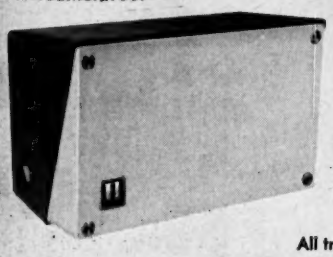
is safe, simple, economical to install

HERE'S HOW THE *ElectriK Tel-O-Set* SYSTEM WORKS

The basic system consists of a transmitter, receiver, controller and final control element. The transmitter measures the process variable, translates it into a standard 4-20 ma d-c signal, and transmits to the receiver through a pair of unshielded wires. The receiver indicates or records the signal in terms of the actual value of the process variable, compares it with the set point, and sends the difference to the controller as an error signal. The controller then converts this into a corrective 4-20 ma output to operate the control valve —again transmitting over a pair of unshielded wires.

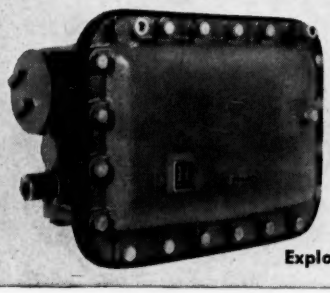
TRANSMITTERS

Weatherproof



Relay rack

All transmitters are completely transistorized and have quick-connect electric plugs. All process and external electric connections to transmitters are isolated from the inside of the case, to permit installation without the need for instrument department supervision.



Explosion-proof

Just two wires connect field-mounted units of the new *ElectriK Tel-O-Set* to your control room. These wires carry both signal and power. No line power connections in the field—only in the control room.

There's complete freedom from stray pick-up and changing line resistance in this d-c system. No shielding required. Standardized components, together with extensive use of quick-connect and plug-in design, give you ready interchangeability of parts, reduced spare parts inventory and easy maintenance.

ElectriK Tel-O-Set, the simplest system for process control, will bring you major savings in installation man-hours and materials. Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, 21 Penn St., Fall River, Mass.

*Tradename, Minneapolis-Honeywell Regulator Co.

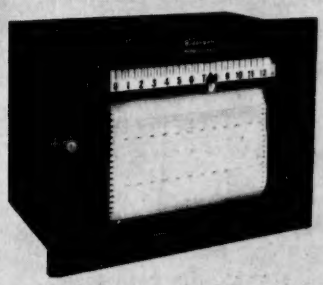
Honeywell

First in Control

RECEIVERS

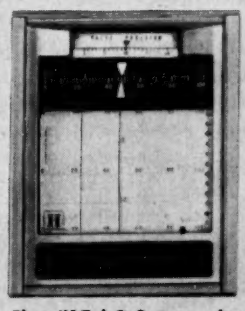
Millivoltmeter

Multipoint recorder



Many types of receivers can be used with the system for local and centralized data presentation, adjustable cascade control, ratio control and many other auxiliary functions. *ElectriK Tel-O-Set* transducers make the line completely compatible with your present pneumatic instruments.

4-20 ma d-c
(no shielding required)



ElectriK Tel-O-Set recorder

Miniature milliammeter

SPROUT-WALDRON Pointers

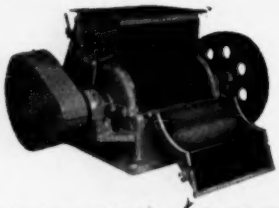
for Mixing and Blending • Size Reduction
Size Classification • Bulk Materials Handling • Pelleting and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

PHENOLIC STOCK REDUCED IN SAW TOOTH CRUSHER

The reduction of calendered sheeting for phenolic molding compounds is being accomplished in a single pass through a heavy duty Sprout-Waldron saw tooth crusher. The warm material comes to the crusher in strips 6″ to 9″ wide, 12″ to 18″ long and in a variety of thicknesses. It is reduced to approximately ½″ square pieces.

This precision-built heavy duty 16 x 25 Saw Tooth Crusher has been in successful operation at the

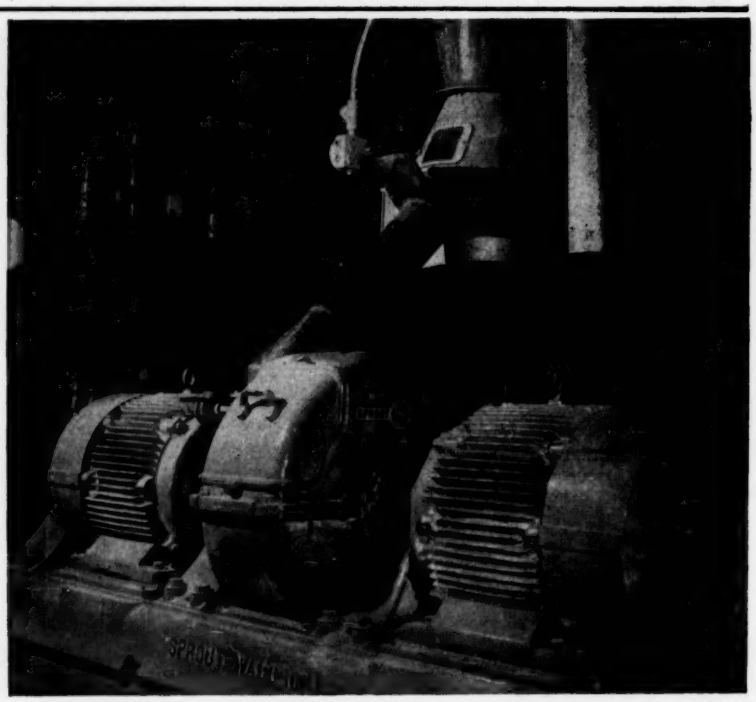


This Sprout-Waldron 16 x 25 Heavy Duty Saw Tooth Crusher has given more than 10,000 hours of satisfactory service in the crushing of phenolic stock at General Electric.

General Electric Company plant in Pittsfield, Massachusetts for over 10,000 working hours, and it is still going strong. Its hard faced 16″ diameter breaker saws are designed specifically for the reduction of tough or brittle materials. In fact, everything about this crusher suggests high productivity under the most demanding conditions. Here are some of the key design points:

1. Precision-built.
2. Hinged covers to facilitate inspection or servicing.
3. Rugged construction. Alloy steel round shafts, mounted on large roller bearings.
4. Close fitting shrouds to prevent material by-passes.

For details, request Advance Specification Sheet No. 204.



STREAM SPLITTER KEEPS ATTRITION MILLS ON THE RUN

A few years ago the American Distilling Company installed a 26″ Sprout-Waldron double runner attrition mill for the grinding of corn, milo, rye, barley malt and other ingredients used in the production of Bourbon Supreme Whiskey, corn and rye whiskeys and grain neutral spirits. The mill discharged into a mechanical handling system consisting of a screw conveyor and bucket elevator.

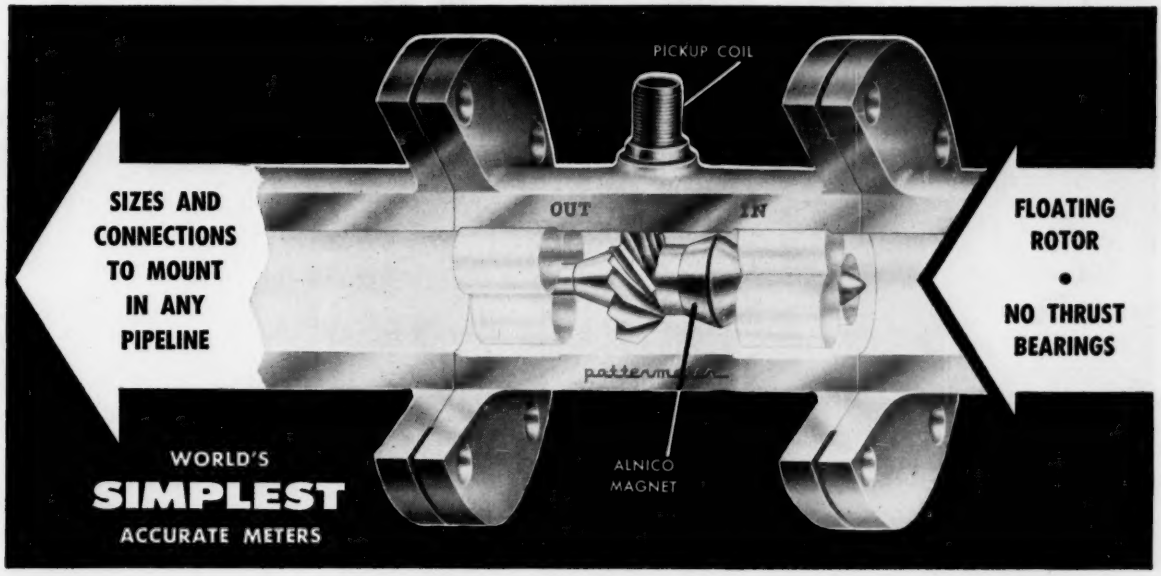
As the need for expansion became obvious it was decided to install an identical Sprout-Waldron attrition mill to operate in parallel with the existing machine, providing greater flow rate, reduced wear and simplified maintenance.

The key to the new system is a Sprout-Waldron Model VA-5 stream splitter with two outlets which divides the flow equally between the two attrition mills. Four whole grain storage bins discharge to a common Sprout-Waldron 12″ x 18′ screw conveyor. The center outlet of the conveyor allows the grain to pass over a magnetic separator on the way to the stream splitter. As the ground grain emerges from the attrition mills it is conveyed to the roof of the building by a Sprout-Waldron 50 hp 44″ Pneu-Vac negative pressure system to another ground grain storage bin where it is held for further processing into quality whiskeys. For the facts on the Sprout-Waldron line of precision stream splitters, ask for Bulletin 137-B.

CP/106

pottermeter BOWSER ESTABLISHED 1885 **0.1 GPM TO 40,000 GPM**

ELECTRONIC TURBINE TYPE METERS



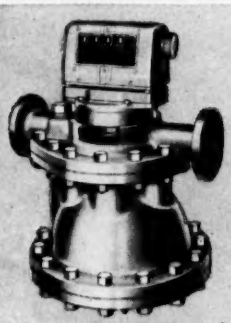
for PETROLEUMS • CHEMICALS • FOODS
PHARMACEUTICALS • INDUSTRY LIQUIDS

A magnet built into the turbine driven rotor generates electric current directly proportional to the flow rate of liquid in the pipe. This impulse is used to activate electronic control and readout equipment near the meter or at remote locations. Accurate over wide range of flow rates and pressures. Handles liquids and gases.

Flow Ranges	to 40,000 g.p.m. and more
Operating Pressures	Unlimited
Temperature Ranges	−455° F. to +1500° F.
Pressure Drop	Virtually Nil
Connections	No limitation
Construction (standard)	Type 316 stainless steel with Carpenter #20 Rotor

READOUT and CONTROL equipment as needed

Potter-Bowser engineers gladly confer with systems engineers to provide data on any application requirements.

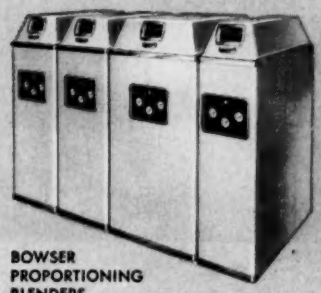


BOWSER XACTO METERS

BOWSER XACTO METERS AND PROPORTIONERS
positive-displacement piston type

Wherever mechanically driven readout and control equipment is indicated, and where positive-displacement metering is needed or costs less, Bowser Xacto Meters (leading all others in industry) are unexcelled for dependability and accuracy. Capacities: 6 GPH to 250 GPM

Xacto Meter equipped proportioners are used to blend two or more liquids in continuous flow at accuracies to ¼ of 1 percent. First in lube oil blending. Bowser proportioners also handle most other liquids used by process industries.



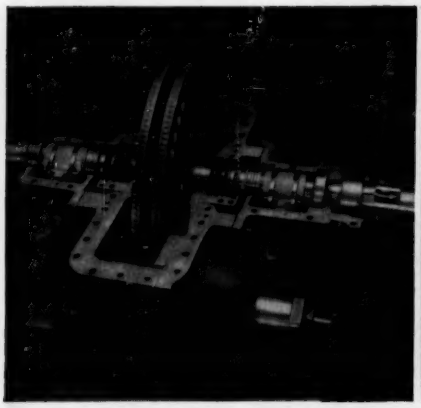
BOWSER PROPORTIONING BLENDERS

Write For Catalog

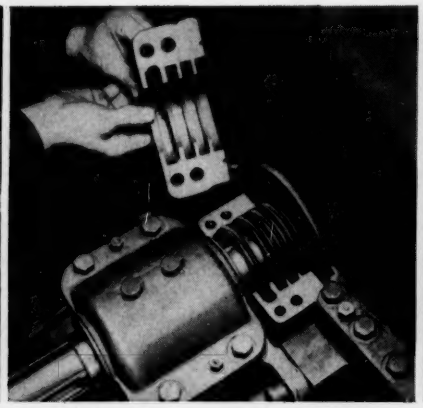
Potter-Bowser Division* BOWSER, INC. *Fort Wayne, Indiana

Economical in operation...
Dependable always

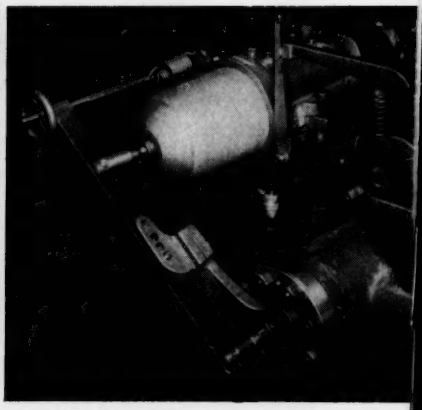
ELLIOTT



Precise alignment of shaft, through true centerline support, permits smooth and dependable operation at all operating temperatures. The entire rotor assembly is dynamically balanced.



Accessible shaft-seals simplify maintenance and routine inspection. Shaft surface under packing glands is stainless steel. Covers are readily removable without disturbing the upper-half casing.



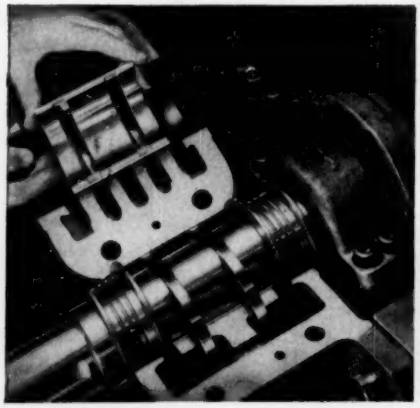
Simple, Positive direct-acting speed-governing system is dependable, weather-proof, accurate. Separate trip gives positive overspeed protection, and it may be easily reset against line pressure.

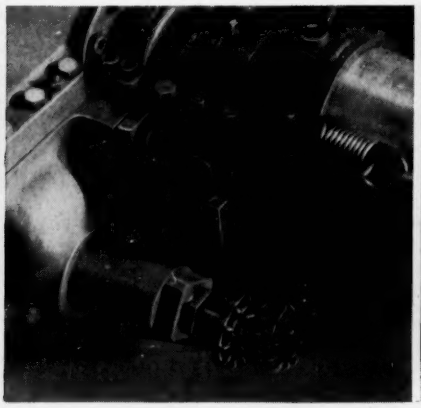
Only ELLIOTT Turbines give you all these PLUS features

By separating the pedestal-mounted exhaust-end bearing from the hot turbine casing, the temperature distortion is minimized, and the vertical shaft movement is thereby eliminated.

Steam-saving hand valve with pilot, which can be opened against full steam pressure, reduces steam consumption at partial loads. This feature is available on all sizes of Elliott YR steam turbines.

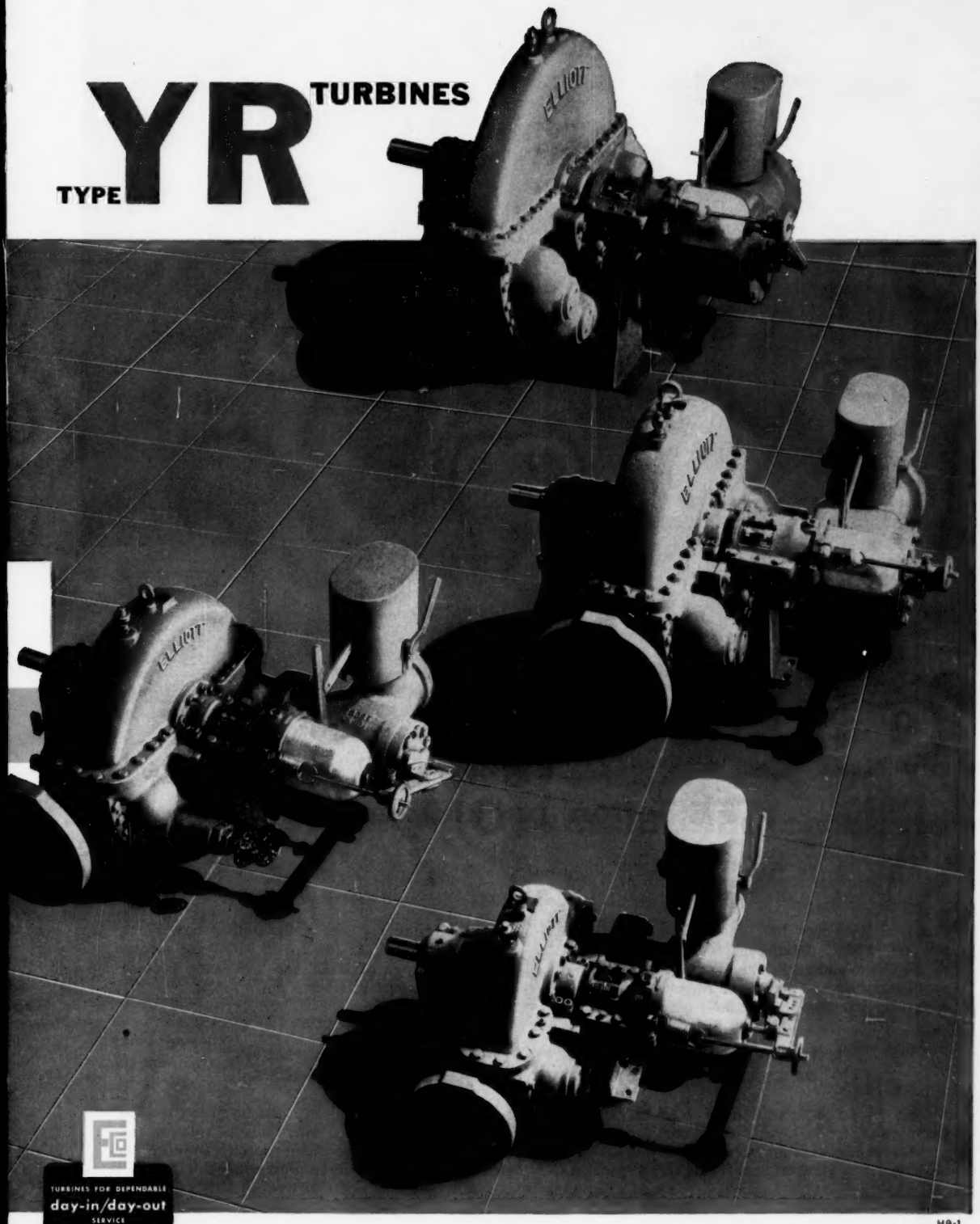
All-weather protection is standard for Elliott YR turbines. They shrug off heat, dirt, snow, moisture or contaminated atmosphere. Stainless steel exposed parts are furnished for extreme conditions.





In addition to the units illustrated here, Elliott makes single-stage turbines in special frames, reduction gears, multistage mechanical drive turbines to 50,000 hp, and turbine-generators ranging through 44 mw.

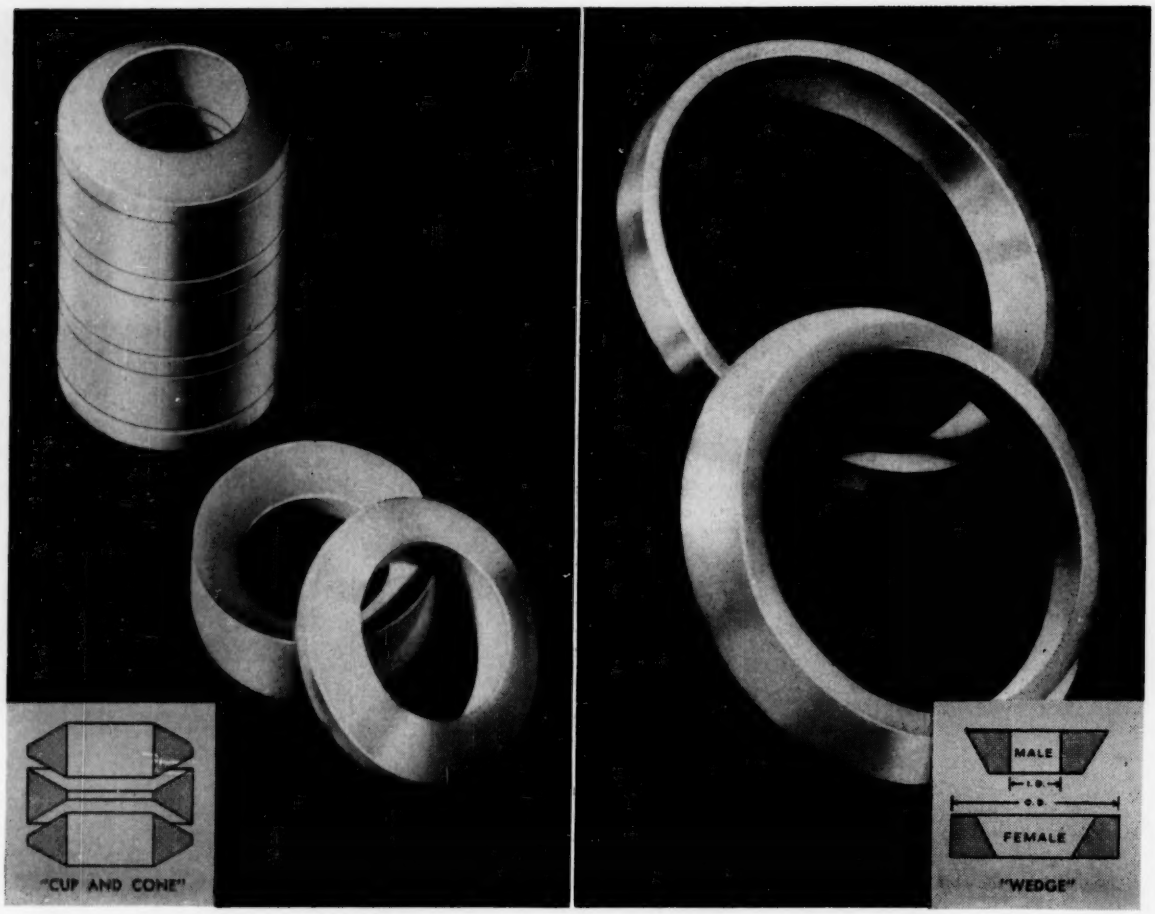
TYPE YR TURBINES



TURBINES FOR DEPENDABLE
day-in/day-out
SERVICE

H9-1

ELLIOTT Company JEANNETTE, PENNA.



try New CHEMPRO "cup & cone" and "wedge" TFE Teflon† packing sets

The New Resilient, Low Gland Pressure Packings for Valves, Heat Exchangers or Other Static or Semi-Static Applications

Chempro Style No. 300 "Cup & Cone" and Style No. 305 "Wedge" packing ring sets make tight, secure seals under minimum gland pressure. A nominal force applied to the gland causes the rings to slide against each other, exerting pressure both against the stem or rod, and against the bore of the stuffing box. These two popular styles are being used with great success in a wide range of static and semi-static packing applications where rotation is not a factor.

COMBINATION PACKING SETS FOR ROTATING EQUIPMENT OPERATING ON CORROSIVE AND ABRASIVE SERVICES

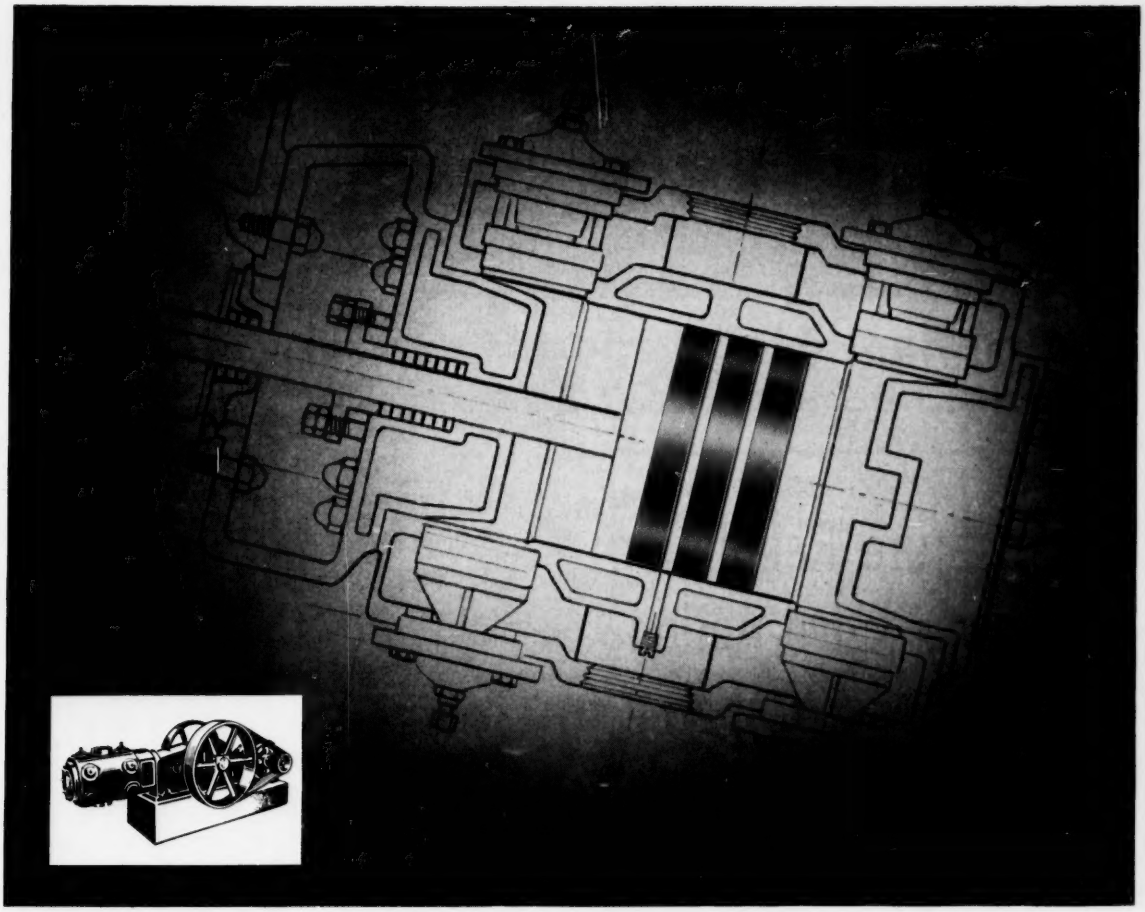
By the proper combination of resilient, sensitive Chempro "Cup & Cone" or "Wedge" rings with tough, pressure-resisting Chempro Style No. 101 packing rings (the original TFE Teflon packing), combination sets have been made up giving months of extra service life to a wide range of rotating and reciprocating type equipment operating under extremely corrosive or abrasive conditions.

CHEMICAL & POWER PRODUCTS, INC.
5 Broadway, New York 4, N. Y.

The Original Fabricators of Teflon Packings and Gaskets

Write for revised Chempro Bulletin No. CP-552 giving the complete story and specific ordering information.

† DuPont trademark



Piston rings made with TFE resins cut replacement and maintenance costs

In a heavy-duty compressor, a set of piston rings and wear rings (shown above) made of a filled TEFLON TFE resin has made possible substantial savings in replacement and maintenance. The rings that were replaced by rings of TEFLON TFE resin cost two and one-half times as much, and lasted less than a week on the average. The rings made with the TEFLON TFE resin were still in operation after three and one-half years of service. According to the manufacturer, maintenance savings amount to approximately $3,750 labor/year/machine.

The unique combination of properties offered by TFE resins makes possible improved performance, greater reliability and lower costs in all types of floating-ring applications. TFE resins have the lowest static coefficient of friction of any solid material —less than 0.04. They eliminate problems of slip-stick, and permit the use of non-lubricated rings. In addition, their exceptional resistance to temperature extremes and their complete inertness to almost all chemicals and solvents make them ideal sealing materials under the adverse conditions often encountered in the chemical industry. In everyday seal applications as well, floating rings of TFE resins provide longer life, safer and more reliable operation and reduced maintenance costs.

Find out more about TFE-fluorocarbon resins and how they can lead to improved seals of all types. Write to: E. I. du Pont de Nemours & Co. (Inc.), Advertising Department, Room T-10105, Nemours Building, Wilmington 98, Delaware—or consult your supplier.

DU PONT

Reg. U.S. Pat. Off.

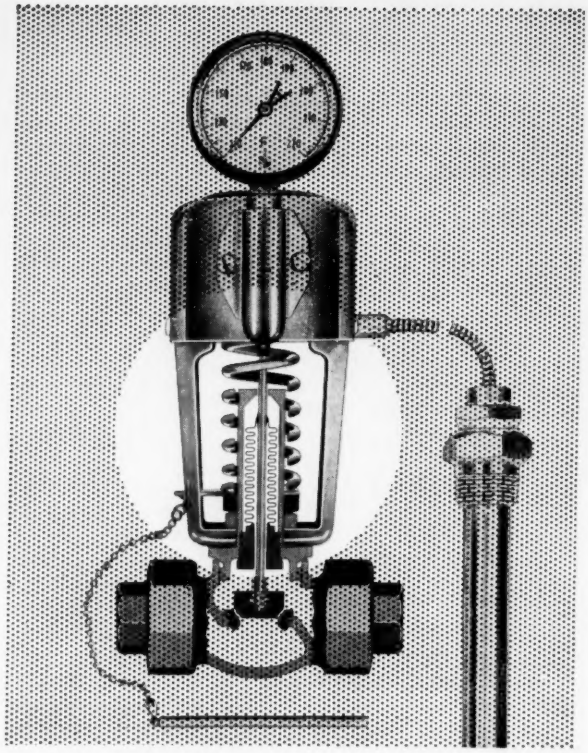
TEFLON

TFE-FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

Temperature Regulation with Corrective Action within 1/10 of a degree



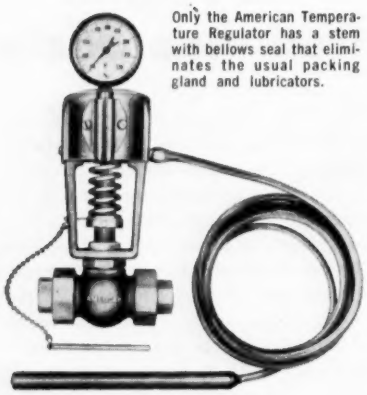
A friction-free bellows seals off the valve stem on the new American Temperature Regulator. Result: no stem binding to retard valve action, fastest possible temperature response.

The bellows seal makes practical a friction-free, nonleaking packless valve that needs no lubrication. This innovation plus an extra-long, preflexed adjusting spring marks the new American Temperature Regulator as the fastest acting, most stable available. Corrective action starts at less than 1/10 degree change at the bulb. And the adjusting spring allows unusual latitude in temperature settings.

Compact design permits installation in "tight" locations. The dial thermometer on the indicating-type regulator can be positioned for easiest reading regardless of piping arrangements. Standardized parts and unitized assembly mean low initial cost. Maximum feasible use of stainless steel and a minimum number of components eliminate maintenance problems.

Get the best in economy, accurate temperature regulation, and dependability. Choose American Temperature Regulators. *Sizes:* ½" to 1½". *Temperature Ranges:* As low as minus 15°F. to 50°F.–as high as 240F°. to 350°F. *Valve:* Bronze body, stainless steel seat and disc. *Ask for Bulletin 114A.*

Phone your industrial supply distributor for counsel, service and prompt delivery from his local stocks.



Only the American Temperature Regulator has a stem with bellows seal that eliminates the usual packing gland and lubricators.

MAXWELL MM&M MANNING & MOORE INC. TRADE MARK

AMERICAN TEMPERATURE REGULATORS

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

Chemico Gas Scrubbers in 415 Installations Provide 90-99.95% Removal Efficiency

"It is unpleasant at best, and can be fatal," is the sum-up by at least one expert about air pollution. The question generally posed is simply, "What can be done about it?"

The chemical processing industry *is* doing something about it. Chemico Venturi gas scrubbers have already been installed for a variety of chemical processes. One reason: the extreme adaptability of this equipment.

ADAPTABILITY PAYS DIVIDENDS FOR MOST PROCESSES

Depending on local conditions, regulations and operating requirements, Chemico equipment can be tailored to solve a wide variety of pollution control problems. Initial installation can be designed to meet minimum needs. If experience or changing conditions call for increased efficiency, this can be achieved to almost any degree with original equipment by merely increasing the power input. Where power costs are a factor, this flexibility feature of Chemico scrubbers is an important advantage.

SIMPLE CONSTRUCTION SAVES MAINTENANCE COSTS

Design simplicity of Chemico Venturi gas scrubbers means that it is possible to utilize materials resistant to corrosion, abrasion or high temperature. This, plus the fact that no critical controls are necessary, holds maintenance costs to the barest minimum. In addition, the small space requirements and complete flexibility of arrangement of Chemico Venturi scrubbers permit installation in existing plants where space is at a premium.

TYPICAL INSTALLATIONS

IRON & STEEL INDUSTRY —
Gray Iron Cupola; Oxygen Steel Converter; Steel Open Hearth Furnace (Scrap); Steel Open Hearth Furnace (Oxygen Lanced); Blast Furnace (Iron); Electric Furnace; Rotary Kiln–Iron Reduction; Crushing & Screening.

CHEMICAL INDUSTRY —
Acid-Humidified SO_3 (a) Scrub with Water (b) Scrub with 40% Acid; Acid Concentrator; Copperas Roasting Kiln; Chlorosulfonic Acid Plant; Dry Ice Plant; Wood Distillation Plant; $TiCl_4$ Plant, TiO_2 Dryer; Spray Dryers; Flash Dryer; Potassium Phosphate; Chemical Incinerator.

NON-FERROUS METALS INDUSTRY —
Blast Furnace (Sec. Lead); Reverberatory Lead Furnace; Ajax Furnace-Magnesium Alloy; Zinc Sintering; Reverberatory Brass Furnace.

MINERAL PRODUCTS INDUSTRY —
Lime Kiln; Asphalt Stone Dryer; Cement Kiln; Dolomite Kiln; Magnesia Kiln.

PETROLEUM INDUSTRY —
Catalytic Reformer; Acid Concentrator; TCC Catalyst Regenerator.

FERTILIZER INDUSTRY —
Fertilizer Dryer; Superphosphate Den & Mixer.

PULP & PAPER INDUSTRY —
Lime Kiln; Black Liquor Recovery Boiler.

MISCELLANEOUS —
Pickling Tanks; Boiler Flue Gas; Sodium Disposal Incinerator.

FULL DETAILS AVAILABLE—For your copy of a new brochure giving complete data on Chemico Venturi gas scrubbers or for technical assistance on a specific problem, write to the address below.

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York

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RODNEY HUNT

FLUID PROCESSING

RODNEY HUNT MACHINE CO., Process Equipment Division, 31 VALE STREET, ORANGE, MASS.

RODNEY HUNT TURBA-FILM PROCESSORS SOLVE COMPLEX PROBLEMS IN MANY APPLICATIONS

Manufacturers of chemicals, foods, pharmaceuticals and many other products have found in the Rodney Hunt mechanically aided thin-film processors a simplified solution to complex problems in concentration, deaeration, distillation, evaporation, homogenization and other processes. In one pass—continuously and rapidly—the Turba-Film Processor provides heat and mass transfer for processing liquids and slurries. Since product quality can be checked continuously and controlled instantly, production errors and costly re-runs of reject material are eliminated.

HOW THE TURBA-FILM PROCESSOR WORKS

The feed stream enters the TURBA-FILM PROCESSOR at the top of the thermal section shown in Fig. A. The high speed rotor blades force *all* of the feed against the inner shell surface by centrifugal force and simultaneously form descending fillets of liquid product on the leading edge of each rotor blade as illustrated in Fig. B. The fillets rotate with the blade movement, imparting compressive and rotational forces against the film of liquid at the heat transfer surface of the inner shell, forcing the film to combine with the fillets. The product material at the shell wall normally possesses a *boundary-layer* flow distribution but the design of the rotor blades makes the "effective" thickness of this product film considerably less than the clearance between the rotor blades and the shell wall. The fluid which would normally reside at the shell surface thus descends as a component of the fillets, traveling through the entire thermal section in a very short and precisely controlled period of time... frequently as little as a few seconds.

Where an application involves vapor-liquid equilibrium such as occurs in mass transfer operations of concentration, dehydration, deodorization, evaporation, heterogeneous reaction, absorption, stripping or distillation, a highly active interface is established at the surface of the fillets where the liquid and vapor phases are in contact. This dynamic activity greatly implements the transfer of material from one phase to the other. The vapor or gas passes upward in counterflow through the thermal section to the separator from which entrained material may be refluxed or recycled to the thermal section with maximum utilization of heat and mass transfer potentials.

TURBA-FILM PROCESSORS OFFER THESE COST-CUTTING ADVANTAGES

Simplified installation... compact design, readily accessible piping connections, and the new support brackets combine to make installation quick, easy and economical.

Less floor space... because of high capacity, continuous operation and low process hold-up, less floor space is required than with conventional equipment.

Quality control... since relatively small amounts of product are in process at any given moment, the condition of the product can be checked continuously and controlled instantly.

Minimized cleaning... Turba-Film units can operate for long periods of time without cleaning because formation of boundary layers, crusts, crystals and other deposits on heat-transfer surfaces is almost completely eliminated.

Flexibility of use... Low process hold-up permits quick and easy changeover from one product to another to provide for extremely broad flexibility of use.

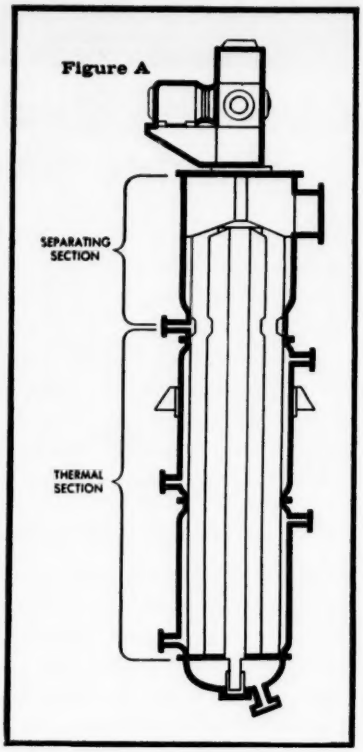


Figure A

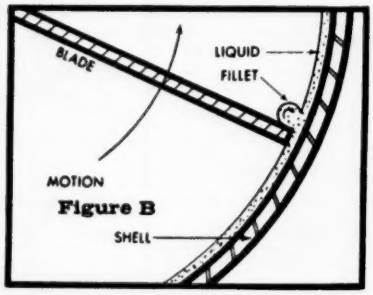
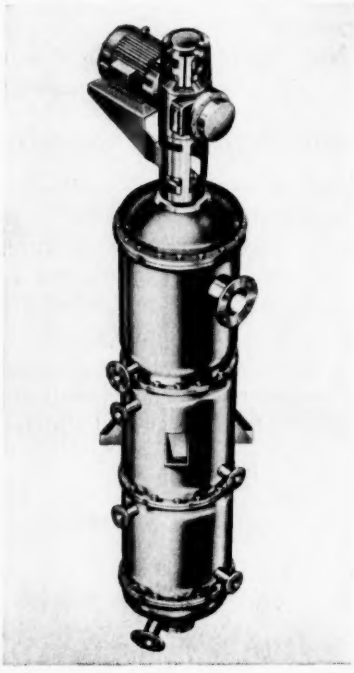


Figure B



FILL IN COUPON FOR MORE INFORMATION ABOUT RODNEY HUNT PROCESSING EQUIPMENT

Please send me the bulletins checked.

- ☐ THE TURBA-FILM PROCESSOR
- ☐ THE VACU-FILM PROCESSOR
- ☐ THE LABORATORY VACU-FILM PROCESSOR

Name.....

Title.....

Company.....

Address.....

Mail to: Rodney Hunt Machine Co., Process Equipment Division, 31 Vale Street, Orange, Mass.

DEVELOPMENTS . . .

OCTOBER 5, 1959

Chementator

T. P. FORBATH

Firestone has cast a weighty vote for nylon in the tire-cord wrangle. Company's revamping ex-textile mill at Hopewell, Va., to produce nylon-6 filament by mid-60. Move marks big Firestone push into synthetic fibers, plastics. Next product: polypropylene.

Unidentified chemical is reported to make flotation separation of beryl ore possible. Four mining firms have formed Dynamics Metals Corp. to exploit discovery.

New catalytic hydrodealkylation process, tabbed Hydeal, is up for licensing. Developed by Universal Oil Products and Ashland Oil, process produces benzene from toluene, other heavier aromatics. Too, it may be used to make phenol, naphthalenes from alkyl ring compounds.

Census tallies size of CPI

How big is the U.S. chemical process industry? One effective measure is given by the just-completed 1959 McGraw-Hill Census of Chemical Process Plants.

Using a three-way breakdown—by industry segment, by plant size in terms of employees, by geographic area—this study has counted up the number of operating chemical plants in this country and the number of people employed in them. And, as a valuable bonus, it's also counted up the number of plants making chemicals as a secondary product and their employees—a chore not tackled by previous McGraw-Hill censustakers in 1952.

A detailed analysis of the census will be published in the November 2 issue of *Chemical Engineering* but here's a look at some of the grand totals until then.

All told, there are 3,380,216 people working in 14,109 plants with 20-or-more employees on the payroll; 3,237,060 people in 9,497 plants with 50-or-more; and 3,007,879 in 6,057 plants with 100-or-more. Of these, 1,890 plants of the 20-plus size employing 657,559; 1,384 of the 50-plus size employing 641,146; and 937 of the 100-plus size employing 610,822 produce chemicals as secondary products.

Aluminum-propellant activity popping

Hard on the heels of recent disclosure (*Chementator*, Aug. 10, p. 56) that Atlantic Research's solid propellant Arcite gains added punch from aluminum powder, word comes that at least three other firms are hard at work on the material with the same application in mind. And with this word also comes—albeit muffled by a thick security blanket—the first sketchy description of how the metal powder is made in the ultra-fine sizes needed.

• Vitro Labs reveals to *CE* that it's now readying sample quantities of spheroidal aluminum powder ranging in particle size from 80 down to 20 millimicrons dia. Material, com-

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ARK-trol®

ELECTRICAL CONNECTORS

• Foolproof polarization • Errorless assembly • Maximum interchangeability • Environmental: Exceed rigid military and industrial requirements for resistance to corrosion, chemicals, high and low temperatures, pressure, shock, vibration, dust, humidity, moisture, and leakage of air.

POSITIVE POLARIZATION

Completely foolproof: plug can be mated only with proper receptacle, and in only one way . . . the *right* way. Unsymmetrical contact arrangements preclude improper mating of contacts, or mating of unmatched contact configurations.

FAST, EASY, ERROR-FREE ASSEMBLY

Polarization keyways and unsymmetrical contact arrangement in insert assemblies make improper assembly of parts impossible. One-piece 'snap-in' connectors. Soldering is done outside . . . *before* insertion of contacts.

SEALED AGAINST ENVIRONMENTAL FACTORS

'Stack' assembly includes silicone rubber wafer for impenetrable seal against water, vapors, dust, gas. Basic shells, other metal parts are high-strength extrusions of aluminum alloy, anodized for corrosion, abrasion resistance: 1800 volts are required to penetrate this coating.

MAXIMUM INTERCHANGEABILITY

Components in each diameter are interchangeable and reversible, doubling scope of equipment. Male *and* female shells take either pin or socket inserts: both plug and receptacle may be used 'hot' or 'dead'. Pin and socket configurations available in wide range . . . specials supplied on request.

SHELL SIZES and ELECTRICAL RATINGS

Four shell sizes: from 1-1/16" to 2-9/16" diam. *Voltages:* Military Service Ratings: A, D, E, B, C and Instrument. NEC Rating: 600V. A.C. *Contact sizes:* #16 to #4/0 inclusive. Write for Bulletin 2711 containing complete descriptions, specifications and configuration patterns for both Type RPE and RPC *ARK-trol* Electrical Connectors.

Available in two types:

TYPE RPE ENVIRONMENTAL
- Moisture Proof
- Shock Insulated
- Dust-Tight
- Corrosion Resistant
- Grounded & Non-Grounded

TYPE RPC CIRCUIT BREAKING
- All Features of RPE *Plus* . . .
- Circuit Breaking under full Rated Load

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pany reports, is made by the Sheer-Korman high-intensity arc (*Chem. Eng.*, Dec. 29, 1958) used successfully for producing manganese from rhodonite.

• National Research Corp. identifies itself to *CE* as Atlantic Research's aluminum powder supplier. Company has been two years at job of developing a process for making metal particles of 0.25 microns dia. Too, NRC has just been awarded a $100,000 classified contract by Navy Bureau of Ordnance for "preparation and determination of properties of ultra-fine aluminum."

• Thiokol Chemical has been researching aluminum-in-propellants at its Redstone Arsenal operations for five years. Now, *CE* learns, company has plans for purchasing commercial-grade aluminum powder from one of several major aluminum firms (e.g., Alcoa, Kaiser), then reducing particle size to fineness required by rocket application.

Vitro's high-intensity arc is regarded by many experts as the standout process for this job. Reliably grounded industry speculation has it that Thiokol is considering adopting the method for its own use. Another possible process: spraying molten aluminum into vacuum chamber with helium or argon.

Jet-turbine hookup faces stiff test

Idea of hooking a jet engine to a gas turbine to form a power plant package—last month advanced persuasively by Pratt & Whitney and Cooper-Bessemer, and previously by Westinghouse and General Electric—is now in for a grueling on-the-line proveout.

Columbia-Gulf Transmission Co., with a Federal Power Commission application filed for permission to go ahead, is planning to install just such a system in a compressor station at Clementsville, Ky., to pump natural gas through pipelines.

Company's object is to find out how long the jet-turbine hookup can be kept on the line before needing a maintenance overhaul. Columbia's program calls for a modified P&W J-57 jet engine coupled to a C-B gas turbine, delivering 10,500 hp. to a centrifugal compressor, to run for 18 months or 8,000 hr., whichever occurs first.

Notes Columbia VP Sy Orlofsky, reciprocating-engine-driven compressor stations can be operated for that length of time. But conventional aircraft practice has the J-57 coming out of service after only 1,400 hr.

P&W and C-B are strongly convinced that the jet-driven turbine will pass Columbia's stiff test. Reason: They've put a 600-hp. system through equally punishing paces in laboratory testing.

If Columbia's installation does in fact prove out, engineers have a very attractive power plant package to begin sizing up. Use of jet engine looks like it can slice initial investment by as much as half. Estimates Orlofsky, thanks to compactness and light weight of the J-57, ground-up initial cost of jet-driven compressor stations should run around $190/installed hp. Reciprocating-engine-driven stations figure out at $355/installed hp.

Mobile unit sprays fluorocarbon foam

Rigid-urethane-foam insulation blown with fluorocarbon gas instead of carbon dioxide now seems likely to find a place in chemical plants as well as refrigerators (*Chementator*, Dec. 1, 1958).

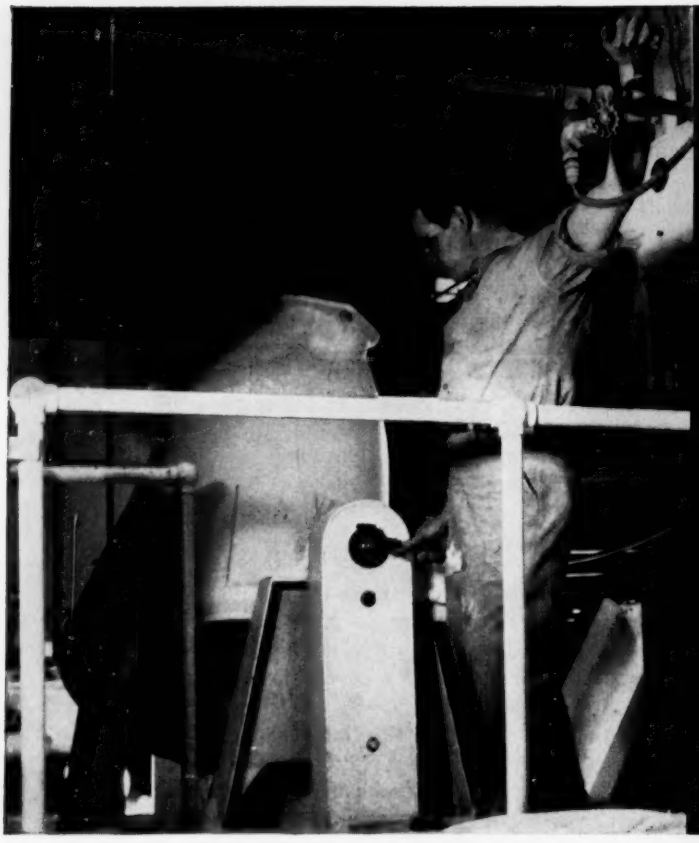
Wyandotte Chemical and DeVilbiss Co. have developed a compact portable system to spray polyether-based urethane foam with Freon, Genetron and other similar foaming agents. Result: A unit that can be wheeled around a plant, be used to spray vertical surfaces with foam coats over 7-in. thick at rates of 3-5 lb./min. in densities around 2-4 lb./cu.ft. and offer plant engineers the advantage of exceptionally low thermal conductivity foam insulations.

Previous to this development, urethane foam employing fluorocarbon foaming agents could be applied only with bulky "pour-in-place" equipment, and then only to fill cavities between supporting walls—as in the case of refrigerators.

New unit looks and handles much like the urethane-foam spraying systems using CO_2 as foaming agent that have been in successful chemical plant service for several years. But to operate on fluorocarbon gas, system requires a specially designed spray gun of DeVilbiss' and a special formulation of polyether-isocyanate prepolymer and catalyst developed by Wyandotte.

Key attraction of the new system is that, by using fluorocarbon gas instead of CO_2, thermal conductivity of urethane foam is virtually halved. For example, K factor of 2 lb./cu.ft. of foam blown with fluorocarbon

(Continued on page 40)



P-K LIQUID-SOLIDS® BLENDER AT UNIVERSAL CLAY PRODUCTS CO.

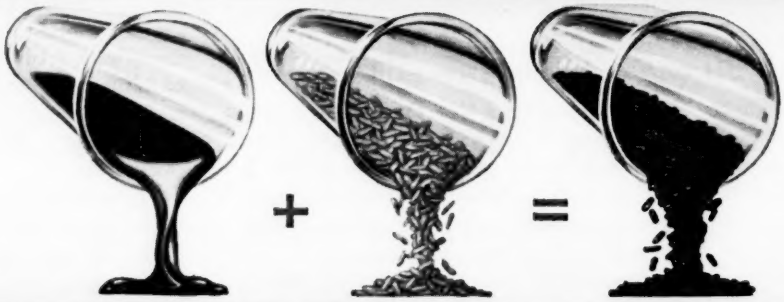
Clay body mixing is faster and simpler with a 20 cu. ft. P-K Liquid-Solids Blender* at Universal Clay Products Co., Sandusky, Ohio. The unit pre-blends, adds water, post-blends and discharges 900 pounds of spherically granulated body clay for electrical porcelain. Time is only 12 minutes. Previously this operation required a pulverizer and three-belt conveyor system built around conventional muller-type mixing equipment. Mixing time reduction: 20%. Equipment and installation savings: 50-55%.

The controlled spherical granulations produced by the Liquid-Solids Blender give still further advantages. They fire into a stronger porcelain. And they give easier release on some dies. This speeds production in piece-work operations.

As shown at far right, clean-up requires only hosing down with water. All blender surfaces are freely accessible. Complete discharging of batch is accomplished in minutes.

Before installation, Universal Clay pre-tested formulations at the P-K pre-test laboratory in East Stroudsburg, Pa. Moisture content and control were worked out. Blending procedures were established. All of which minimized scale up and procedural adjustments.

Universal Clay makes electrical pole-line and switch-line porcelains and foundry and custom-tailored ceramics. A broader application of P-K Liquid-Solids Blending is planned in the future.



BLENDS ANY LIQUID

A new centrifugal Liquid-Solids blender has evolved from P-K's patented "Twin-Shell" design. It blends never-before-practical combinations of liquids and solids! It reduces conventional blending operations to a single step!

For new combinations of liquids and solids, this amazing blender offers untold advantages. Applications are limited only by imagination. They range from chemical reactions to coating very light solids such as cork, to producing all types of controlled granulations from fine to coarse.

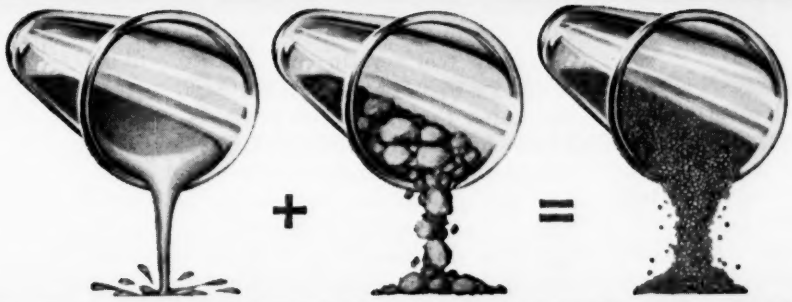
In conventional applications, the one-step P-K Liquid-Solids blender often eliminates two and three separate stages of blending, pulverizing and screening. It replaces a multiplicity of equipment. It reduces equipment investment and materials handling costs.

P-K Liquid-Solids units blend from ½% liquids by weight to whatever percentage solids can absorb and still remain a solid. Blending requires minutes, not hours. It involves four simple actions: 1) Dry Solids are charged to about 65% of shell volume. 2) Solids are tumbled and aerated to break up agglomerates. 3) Atomized liquid is dispersed through patented centrifugal spray discs. 4) Product is discharged from the bottom of the blender.

All surfaces of the blender are freely accessible. The Liquid-Feed bar is easily removed. These features speed cleaning and safeguard against contamination. Sizes range from laboratory models to 50 cu. ft. capacity.

CUTS MIXING TIME 20%
REDUCES INVESTMENT 50%

CONTROLS GRANULATION · COMBINES OPERATIONS · SIMPLIFIES CLEAN UP



WITH ANY SOLID

FREE PRE-TEST OFFER. You can preview blending economies at our Laboratory. Pre-testing predicts savings in processing and handling and realistically demonstrates the unique performance of the P-K Twin-Shell blender.

Our pre-test facilities for blenders—and also for P-K Vacuum Tumble Dryers—are at your disposal. Send or bring your test materials. For complete information call (Stroudsburg-Hamilton 1-7500) or write George Sweitzer at our East Stroudsburg Headquarters, 1510 Hanson S..

* Patented

Patterson Kelley

Chemical and Process Equipment Division, East Stroudsburg, Pa.

runs around 0.14 while same density foam blown with CO_2 is roughly 0.24.

Texas water-project feud settled

Settlement last month of the bristling feud between Houston and Trinity River Authority over their jointly proposed water-supply project comes as happy news to the thriving chemical industry in Texas' southeast corner and in other parts of the state as well.

After a year-long dispute, in which charges of piracy and doublecross were bandied freely, the two groups finally worked out the knotty financial details of their $38.5-million proposal. Now construction can start on a project that will (1) add 1.2 billion gal./day of water—of which 840 million gal./day will be earmarked for industrial use—to the strained water resources of the nine-county industrial complex fanning around Houston; (2) bring water transportation to the doorsteps of north Texas cities via a more navigable Trinity.

TRA and Houston will build a large dam and reservoir on the Trinity near Livingston and a salt-water barrier near the river's mouth on the Gulf at Wallisville. Both dams will be designed to permit barge and small-boat navigation up the river.

Under agreement finally reached, Houston will pick up bill initially for all construction costs, take 70% of water made available. On time-payment basis TRA will pay 30% of initial investment by buying 30% of the water from Houston at 6.75 mills/1,000 gal.

First major outcome of project when completed within 4 yr.: development of the Cedar Point area into a chemical processing complex. Area is located east of Baytown and about 2½ mi. north of the Houston Ship Channel. Jones & Laughlin has a several-thousand-acre site there for a possible steel mill.

Paraffins as fuel for jet engines?

Texaco has disclosed that, through joint studies with Pratt & Whitney, it's discovered that jet engines fueled with pure mixture of *n*-paraffins gain sharply in lifting power, non-stop flight range and life, plus exhibit virtually smokeless takeoffs.

Explanation of this discovery: Paraffin fuel burns with a markedly less luminous flame than does kerosene. This means that amount of radiant heat given off is also less, so material can be burned at higher temperatures without overheating interior engine walls.

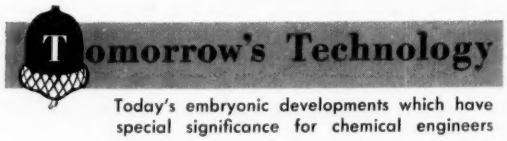
Characterizing its finding as revolutionary, Texaco is gearing itself up for commercial production of *n*-paraffin jet fuel. *CE* learns that company plans to tap paraffin byproduct streams from a Udex unit at its Port Arthur refinery and from a Rexformer unit at its Trinidad refinery for the jet market.

But P&W is not quite as ready to go as Texaco, despite the fact that it's conducted jet engine tests with over 1 million gal. of Texaco's new fuel. One point of hesitation: J-57 engine would have to undergo considerable redesign before it could take full advantage of the low luminosity of paraffins.

As for the airlines, who'd be Texaco's customers, they plan to follow lead of engine manufacturers who guarantee engine performance and fix engine requirements. Nevertheless, a point of high interest to them is expected cost of fuel.

Texaco claims fuel can be marketed at competitive prices. But company admits this could mean at least 2¢/gal. higher than present jet fuels since boiling points of paraffins make them subject to government tax. Moreover, *CE* learns that industry-wise observers feel certain that Texaco will add another 2¢/gal. on top of that. Still, company maintains that increased payloads, extended engine life, etc., possible with new fuel would balance out price differential.

If it's right and fuel catches on, refiners may be faced with a brand-new way of rating jet fuels—the Luminometer Number, a measure of fuel luminosity developed by Texaco. And, predicts the company, this may well open up a numbers race similar to the octane race among the automotive crowd. Texaco points out that kerosene has an L.N. around 40, *n*-paraffins ranging upwards of 150.

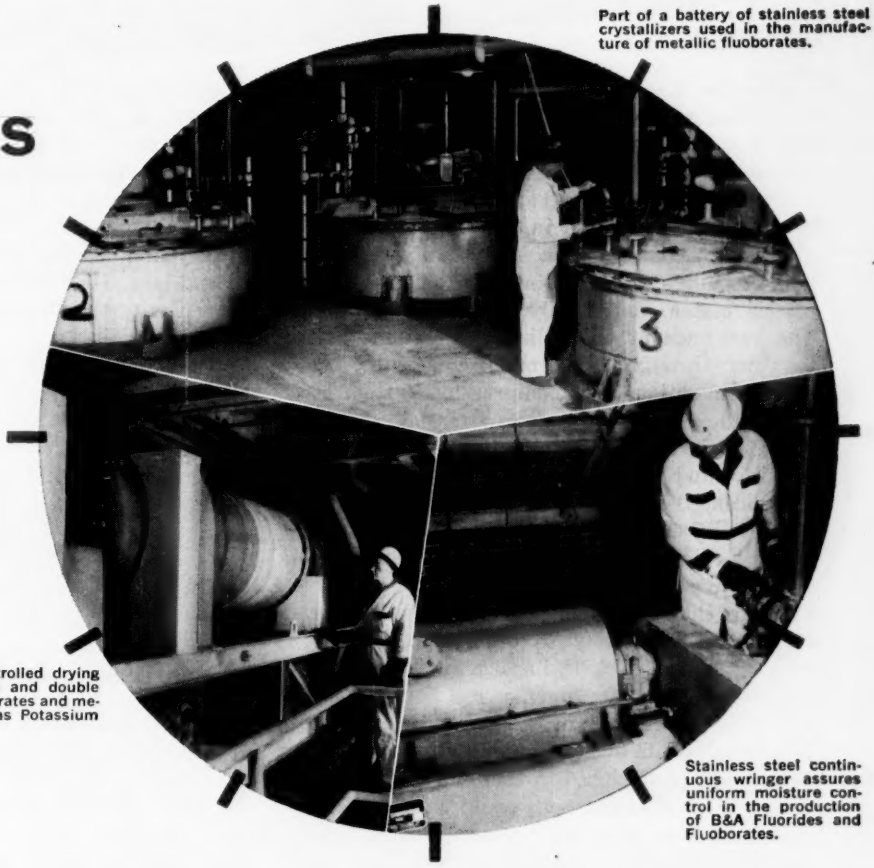


Today's embryonic developments which have special significance for chemical engineers

Tiny "icebox" boon to cryogenics

A tiny refrigerator—and the concept by which it works—promises to be a first-order boon to cryogenics researchers. Unveiled at

FLUORIDES 'ROUND THE CLOCK!



Part of a battery of stainless steel crystallizers used in the manufacture of metallic fluoborates.

Rotary dryer for controlled drying of high purity single and double fluorides, alkali fluoborates and metallic fluorides such as Potassium Titanium Fluoride.

Stainless steel continuous wringer assures uniform moisture control in the production of B&A Fluorides and Fluoborates.

General Chemical's continuous production assures you of dependable, uninterrupted supply

Shown above is part of the versatile process equipment that works round the clock producing America's broadest line of fluorides and fluoborates. The place–General Chemical's Baker & Adamson Works in Marcus Hook, Pennsylvania.

With its broad experience in fluorine chemistry and its extensive production facilities, General Chemical is geared to meet Industry's every need . . . from experimental quantities to commercial tonnages.

Today, our "Baker & Adamson" line includes more than 75 inorganic fluorine compounds. Among them are the following fluorides and fluoborates:

Fluoboric Acid
Potassium Bifluoride
Sodium Bifluoride
Potassium Fluoborates
Potassium Titanium Fluoride
Sodium Fluoborate
Ammonium Fluoborate
High Purity Hydrofluoric Acid
(Electronic, C.P. and Reagent Grades)

For complete list of "B&A" fluorides and fluoborates or for further data on the specific products of interest to you–write or phone the nearest General Chemical office.

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Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

Cryogenics Engineering Conference in California last month, the miniature cooler weighs only 8 oz. and delivers temperatures as low as minus 350 F. It's a striking departure from the usual complex, large and expensive cryogenic refrigerators now in use.

Device consists of a ¼-in.-dia. by 2-in.-long stainless steel cylinder fitted with a plastic piston, unit's only cold moving part. The two ends of the cylinder are connected together through a thermal regenerator. A small conventional gas compression system is included.

Called the MinIRcooler, the refrigerator was invented by Arther D. Little, Inc., and has been licensed exclusively to Hamilton Standard Div. of United Aircraft for commercial manufacture. Its first job: To chill airborne infrared target detectors.

But the scheme by which it operates can be applied effectively to other applications, notably that of simplifying design and reducing size of current cryogenic "iceboxes."

Pressurized helium gas expands through intake valve into one end of the cylinder. Thus cooled, gas is displaced to cold end of cylinder through the thermal regenerator. Because of the large heat capacity of regenerator, gas undergoes no appreciable temperature change. During this cycle, intake valve remains open and more compressed gas is drawn into the warm end of cylinder.

Then intake valve is closed and exhaust valve opened. Gas at cold end expands and so further cools, resulting refrigeration being transferred to the heat load.

A unique feature of this system: Unit's expansion engine doesn't deliver mechanical work. Rather it rejects enthalpy as heat, thus exhaust stream from refrigerator is heated to higher temperature than that of entering stream.

Goal: Chop discovery-to-use time

Are we really trailing the Soviets in research?

Despite the fact that the Russians continue to pull off such remarkable technical feats as putting a rocket on the moon, there's a strong body of opinion that holds we are not. True problem, it maintains, is that we're not getting our discoveries out of the lab and into practical application soon enough.

American Society of Mechanical Engineers concurs with this view. And it has named Fenton B. Turck, New York consulting engineer, to the task of finding ways of chopping the time-lag between test tube and tank car in American industry.

Turck plans to make an exhaustive fact-gathering tour of some 20-25 universities, military and civilian research centers and industrial labs. He'll then prepare a comprehensive report of the views of leading researchers and industrialists.

Stacking up against his effort however is that swelling stream of reports from teams of experts who've toured Soviet research and engineering facilities. One after another they bring word of outstanding Russian accomplishment. Latest: A team of British production experts report that the Soviets are 10 years ahead of the United Kingdom in automation thanks to striking advances in production engineering research.

Ion rocket: A step closer to reality

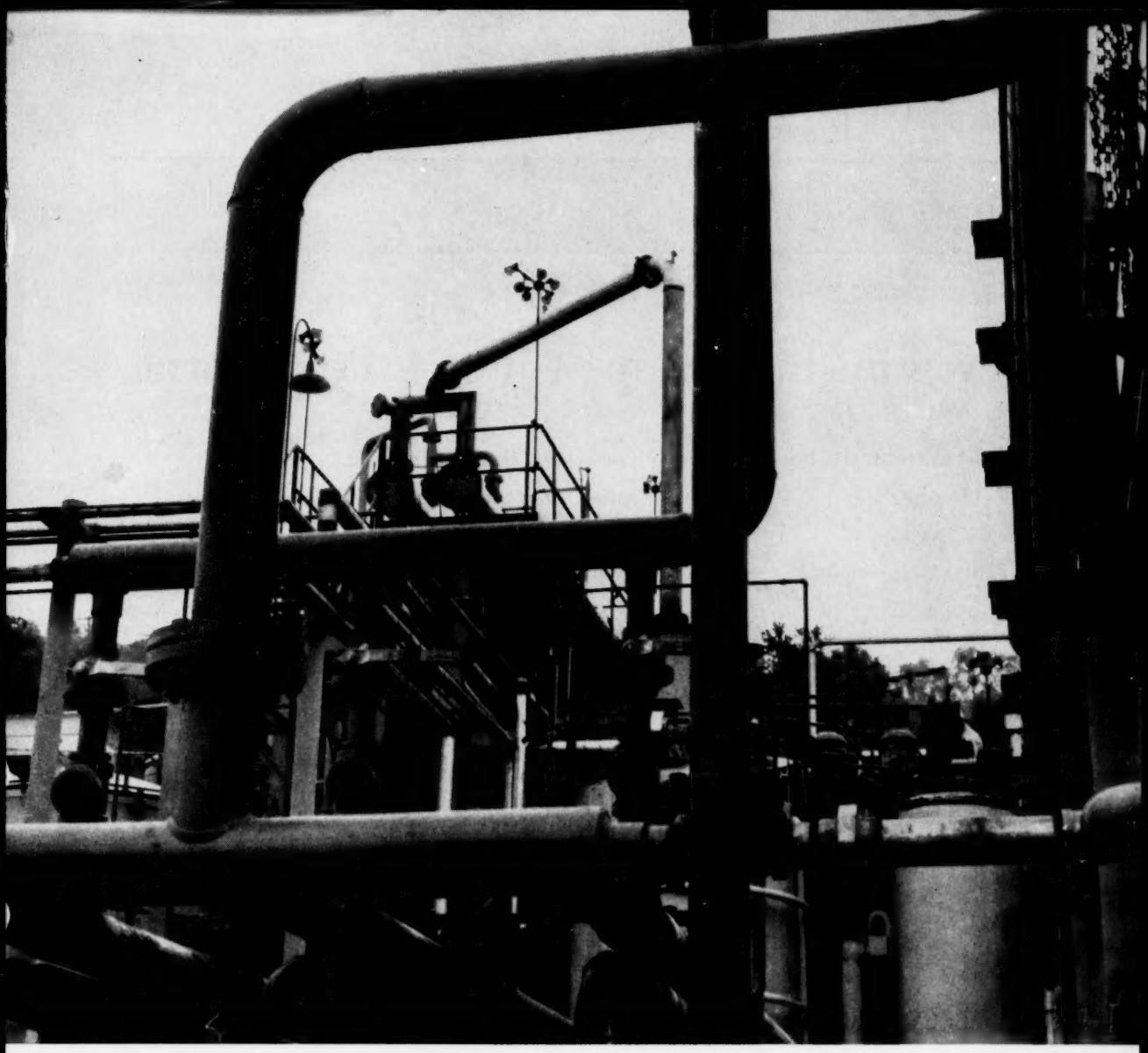
Ion propulsion, perhaps the most Buck-Rogerish idea among rocket propellant systems, has taken a long stride toward reality.

Rocketdyne, a division of North American Aviation, revealed at a meeting of astronauts in London last month that it's been operating a pilot ion thrust device at Canoga Park, Calif., since early this year. Object: To gather quantitative data for the design of a prototype rocket engine. Result of tests: Solid confirmation that ion engines can make practical outer-space power plants. Says company, ion propulsion could be a reality within five years.

System under study by the company uses cesium as propellant. Material is vaporized and fed into an electrically charged chamber. There an electron is removed from each cesium atom. Positive ions created are then pulled out of the chamber and accelerated to over 300,000 mi./hr. by a high-voltage electrostatic field. High-velocity ion stream is discharged through a thrust chamber to provide desired propulsion.

In Rocketdyne's view, first flyable ion engines will be roughly the size of oil drums and deliver only a fraction of a pound of thrust. Yet such small engines will be able to operate continuously for over a year. Used in a cluster to total up 1 lb. thrust, they could drive a 5-ton space vehicle at speeds in the thousands-of-miles-per-hour range.

For more on DEVELOPMENTS.....44



"Stainless Steel reduces material and replacement costs"

reports Mr. William R. Boyles, Plant Manager, Stauffer Chemical Company, Monongahela, Pa.

The Stauffer Chemical Company of New York City is a major producer of industrial and agricultural chemicals. Many of its 52 plants around the country make or process highly corrosive chemical solutions. In the past, equipment at the Chauncey and Monongahela plants had to be replaced about every two years because of corrosion—particularly at pipe joints and threadings. This meant a plant shutdown or a cut in production to make the necessary repairs.

In 1954, after experimenting with other materials, the company decided Stainless Steel was the most suitable metal. It was then used to replace vital parts in equipment. Here are the results at Stauffer's Monongahela plant according to Plant Manager, William R. Boyles: "Stainless Steel has definitely solved most of our problems of equipment replacement. We no longer suffer periodical shutdowns or delays in production because of corroded equipment. Stainless Steel has proven its effectiveness against corrosion. It has saved us time and money. We have had our Stainless Steel equipment in continuous use since the day it was installed—and it's still in excellent condition. In fact, we expect it to last for 15 years—maybe longer."

End corrosion losses in your plant. Build and repair with Stainless Steel. USS Stainless Steel is available through your U. S. Steel representative or your local Steel Service Center.

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USS

New Finishing Steps Change Pulp Form

Irreverent treatment of pulp—pelleting, fluffing and "noodling"—pays off in lower costs, easier repulping.

New sleekly tailored drying and bulk handling techniques are starting to tempt pulp producers away from conventional ways of preparing their products for shipment.

Using these techniques, producers now make pulp in the form of noodles, pellets or baled fluff. In the past, relying on equipment borrowed ready-made from the papermaker, they've shipped pulp either as water-weighted wet lap, hydraulically dewatered sheets or dry sheets.

In the newer forms, pulp costs less to handle. From the producers' standpoint, investment and production costs are lower. A 100-ton/day plant producing baled fluff, for instance, would cost about $180,000, could operate in range of $4-$7/ton, including labor, fuel and electricity.

In turn, the user gets a product that is easier to repulp than pulp prepared by conventional methods.

▶ **Flash-Dried Fluff**—Among these newer techniques, flash dried or fluffed pulp probably has advanced farthest commercially.

Five North American installations, all less than two years old, break mechanically dewatered pulp into fluff for flash drying to 70-100% a.d. solids content (a.d. is air-dry state where pulp contains 10% moisture). Dried fluff is then compressed and baled.

Four of these installations use all or part of the Bauer-Bale system developed by Bauer Bros. of Springfield, Ohio. All four use the system's direct-fired, multiple-pass, rotating-drum dryer.

Oldest is Halifax Power & Pulp Co., Ltd.'s 100-ton/day groundwood installation completed late in 1957. In addition: Waldorf Paper Products Co. has a three-unit installation at its Missoula, Mont., kraft pulp mill; West Virginia Pulp & Paper Co. has one at Luke, Md.; American Box Board has just started up one at Filer City, Mich.

▶ **Halifax Uses Drum Dryer**—Halifax Power & Pulp Co.'s plant, mentioned above, offers a good example of how the Bauer system works for producing dried fluff pulp.

At this installation, groundwood pulp, mechanically dewatered to 40-50% solids, feeds to the fluffer. A small non-precision single-disk pulp refiner equipped with devil-tooth plates, it fiberizes by impact of the intermeshing teeth.

Dryer is direct-fired, heated by furnace gases. Fluffed pulp feeds by gravity into the hot-air stream at the juncture between dryer drum and furnace.

Rotating drum's three telescoping cylinders fitted with compound showering flights provide different heat levels and velocities to accommodate change in drying rate as moisture content of pulp drops.

All material completes three passes before it discharges to the cooling section. Retention time in drum is 30-45 min., depending on inlet moisture content.

Inlet temperature to dryer is 700-710 F.; outlet temperature is 175-200 F. Approximately 17 gal. of oil are burned per ton of air-dried pulp.

▶ **More Than One Way**—Using a different fluff-and-flash-dry system, John Breakey, Ltd., produces 80 tons/day of groundwood pulp at Breakeyville, P. Q., Canada. Handled in Canada and in the U. S. A. by Rice Barton Corp., Worcester, Mass., system provides for some predrying by hot gases in the fluffer before pulp enters suspension-type flash dryer

▶ **Breakey Uses Flash Tower**—At Breakey's mill, using system now handled by Rice Barton, pulp is dried in three stages.

Entering a double-disk pulp fluffer at 30% a.d. solids content, the pulp first contacts hot gases from an oil-fired furnace. Partially dried pulp discharges from fluffer to a 10-ft. cyclone which separates pulp from moisture-laden gas.

Then, pulp enters a second stream of hot gases and is carried through two flash drying towers in series, separated by a second cyclone.

As soon as pulp contacts gas in the dryer, surface water flashes off. Drying towers provide the necessary time to complete the heat exchange and evaporation required for removal of internal moisture.

Burner output and proportion of diluent air are controlled automatically to compensate for initial pulp moisture, atmospheric conditions and pulp throughput rate.

Heat needed to evaporate the water is between 1,400 and 1,600 Btu./lb.

▶ **Noodle Pulp**—Rather than go all the way to a dry pulp, several producers are making a noodle product which is easy to handle and ship in bulk.

For instance, East Texas Pulp & Paper Co. at Evadale, Tex., pumps unbleached stock to an E. D. Jones & Sons' Zenith press. Out of the press into a screw conveyor shoot noodles containing 40% solids. Conveyor discharges into open-top trailer truck.

Delivery point is an hour's drive from the pulp mill. A high-pressure water hose washes noodles out of the trailer into a conveyor feeding the repulper. Total daily delivery is 50 tons, on a bone-dry basis.

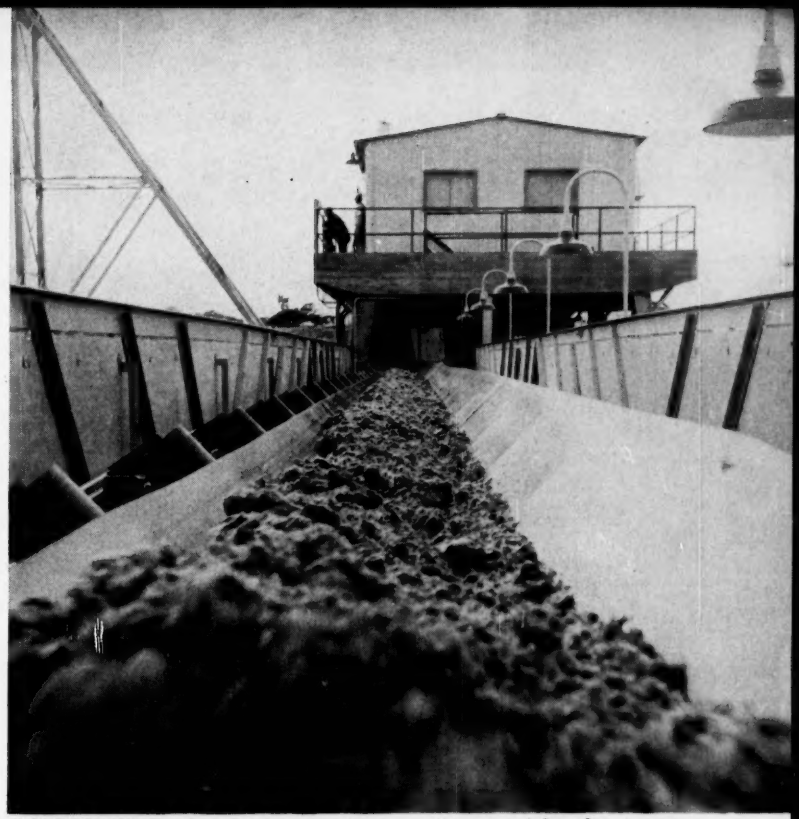
Others shipping noodle produced in this or similar fashion include International Paper Co. (from Mobile, Ala., to Baton Rouge, La.), Crown Zellerbach (from Duncan Bay, British Columbia, to Antioch, Calif.), Charmin Paper Co. (at Little Rapids, Wis.).

▶ **Pelleted Pulp**—Three pilot plants are investigating the economies of putting pulp into another bulk form, pellets.

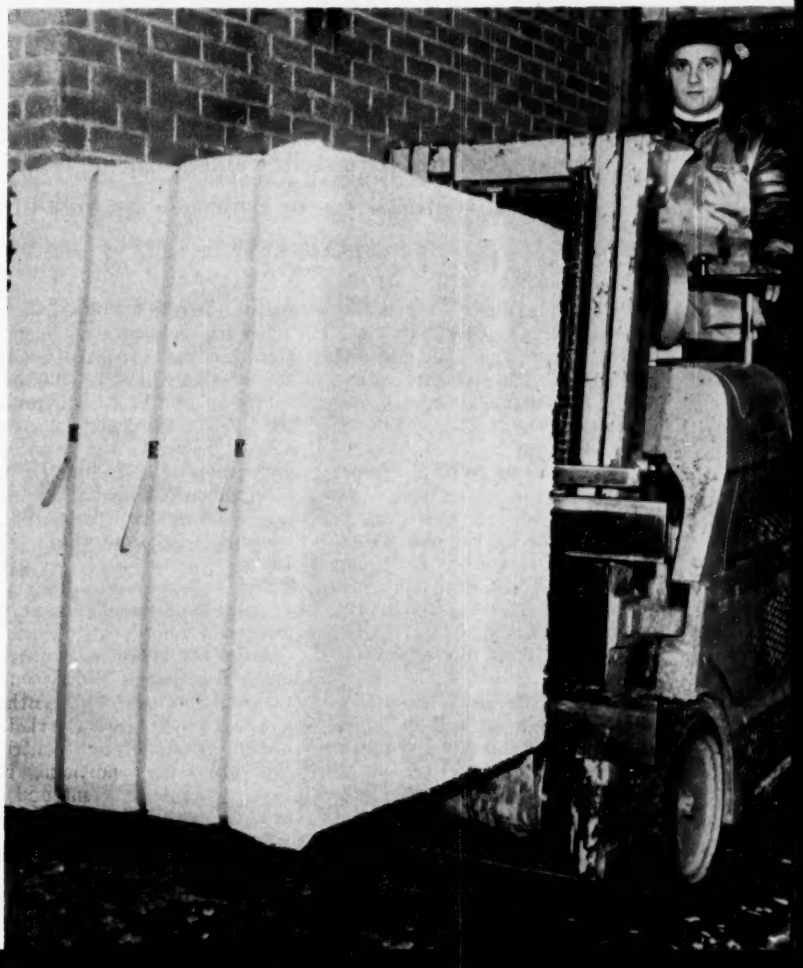
Two are in the U. S. A., one working on pelletizing dissolving pulps, the other on Mitscherlich-type pulp. A third, operating in Australia, is a semi-chemical installation.

In pellet form, pulp remains free flowing during shipping and storage, lends itself to bulk handling throughout. Pellet densities are such that pulp in this form at 90% o.d. solids content (o.d. is oven-dry state where pulp contains no residual moisture) contains approximately 50% more fiber per cubic foot than baled pressed pulp at 35% o.d. So pelleting not only eliminates baling but reduces shipping volume by one third as well.

Pellet mill converts 30-40% o.d. pulp to pellets without reducing moisture content appreciably. However, in its designs, Sprout, Waldron of Muncy, Pa., can include a rotary drum dryer to dry the pellets, if desired.



NOODLE PULP rides a conveyor belt on way from special tanker to outdoor storage pile serving Crown Zellerbach's kraft mill at Antioch, Calif.



FLUFFED PULP, flash-dried, compressed and baled, rides a lift truck in John Breakey Ltd.'s plant at Breakeyville, Quebec, Canada.

SID KIRKPATRICK announces Award to Wayne Kuhn, Gen'l Mgr., Texaco Research and Technical Dept.

CE Award Ballots Are In—Texaco Wins

Nation's senior CE professors rate Texaco tops in chemical engineering achievement during 1956-59 for process that generates synthesis gas or hydrogen by high-pressure flame.

By a wide margin of votes, Texaco, Inc., wins the 1959 Kirkpatrick Award for Chemical Engineering Achievement (formerly the Biennial Award for Chemical Engineering Achievement, see p. 48).

To lay claim to this honor, Texaco outran more than one dozen topnotch corporate candidates. Final choice was determined by votes from a 94-man committee of senior chemical engineering professors across the nation (see *Chem. Eng.*, Feb. 23, 1959, p. 76 for the committee roster).

Ultimate recognition of Texaco's achievement will be given before more than 1,000 chemical engineers and executives at an Award Dinner in the Grand Ballroom of New York's Hotel Astor during Chem Show week, Dec. 1.

In this company of chemical and process industry leaders, Award Chairman Dr. Walter G. Whitman of M.I.T. will present the 1959 Kirkpatrick Award bronze plaque to the Texaco organization. It will be the 15th recognition of chemical engineering achievement sponsored by *Chemical Engineering* since 1933.

▶**The Achievement**—Over a 13-yr. period of technical and commercial development, Texaco pioneered the large scale use of a flame reaction to reduce carbonaceous materials to synthesis gas or to hydrogen. Carried out under non-catalytic controlled high-pressure conditions, reaction is simple, efficient and economical.

Using this process, Texaco can produce cheap synthesis gas or hydrogen from natural gas, propane, butane, various petroleum distillates and residua, lignite and bituminous or anthracite coal. With ability to handle such a broad range of feeds, process enables countries in every corner of the globe to produce hydrogen economically without need for natural gas.

To date, 37 plants spread over 15 countries are licensed to use the Texaco process to produce hydrogen for chemicals and fertilizers, rocket propellants, ore reduction and fuel gas. By making hydrogen readily available in backward geographic areas, process has started a revolution in the supply of fertilizers and in world food production.

Using this microphotometer, Jessop can detect and measure the per cent of even trace elements in a sample of specialty steel.

"How Jessop reads your specialty steels!"

—C. M. Carlisle, DIRECTOR OF ANALYTICAL CHEMISTRY

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"There you'll see how Jessop makes certain you get the exact per cent of alloying elements specified for your specialty steel.

"For example, you'll see a *microphotometer* — that's what I'm peering at so intently in the above photograph!

"I'm studying a film showing the spectrum of a sample of steel from Jessop's No. 2 electric arc furnace. Each chemical element in this specialty steel appears as a distinct line. By reading these lines, I can detect even minute *traces* of elements and after some simple calculations, determine the per cent of each."

This modern chemical laboratory is one more reason why you get your specialty steel tailor-made to your order . . . and you get it on time. **Specify Jessop . . . and then relax!**

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▶ **Nature of Process** — Texaco generates its synthesis gas by partial oxidation of hydrocarbon feed with free oxygen (See *Chem. Eng.*, July 13, 1959, pp. 122-125).

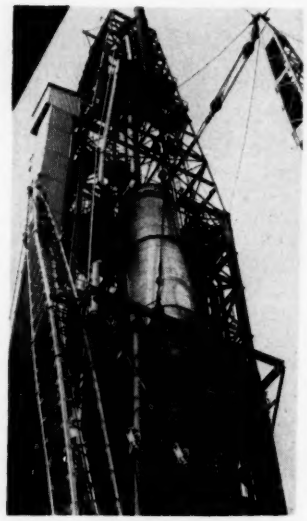
The very high temperatures (above 2,000 F.) and pressures (up to 500 psig.) required to produce gas rich in hydrogen and carbon monoxide are generated within a refractory lined vessel which exposes minimum surface to the hot gases.

This type of generator can operate continuously far above the temperature range for metals. The small surface area and internal configuration of the reactor prevent accumulation of ash or unreacted carbon.

In essence, the partial oxidation reaction proceeds in two stages. First, a primary exothermic flame zone reacts oxygen with part of the fuel to produce carbon dioxide and water vapor. Then, these carbon dioxide and water vapor reaction products react with the balance of the fuel in a secondary endothermic zone to produce hydrogen and carbon monoxide.

▶ **More to Come**—The complete story of how Texaco engineers designed the process and equipment to carry out this partial oxidation reaction will be covered in a special Award section to appear in the November 16 issue of Chemical Engineering.

Tickets for the Award Dinner may be obtained from Chemical Engineering's Editorial Dept. after October 15. Table and seating reservations will be accepted on a first-come basis until November 1.



Building Cat Cracker This Time Is a "Steal"

When Shamrock Oil & Gas Corp.'s Thermofor catalytic cracking (TCC) unit comes on stream soon, it will be, in part at least, a "steal" from Signal Oil & Gas Co.'s Signal Hill, Calif., refinery.

Since Signal is moving its TCC operations elsewhere, Fluor Corp. bought the reactor vessel to install in a new unit that it's building for Shamrock. Fluor then proceeded to pluck the 65-ton reactor vessel from the middle of the 270-ft.-high unit (see photo above), trucked it to a fabricator for new internals and other modifications.

To coax the 52-ft.-high, 11½-ft.-dia. vessel from its supporting structure, Fluor riggers used two hoists, one operating between vessel and structure, the other between vessel and gin pole at right.

Kirkpatrick Award for Chemical Engineering Achievement

More than a quarter century ago, the editors of *Chemical Engineering* conceived the idea of a unique award to recognize outstanding accomplishments in the chemical process industries wrought by the combined efforts of chemical engineers. This coveted honor has been known simply as An Award for Chemical Engineering Achievement.

The first Committee of Award consisted of J. V. N. Dorr, Charles E. Adams, Charles Belknap, Harry A. Curtis, Arthur D. Little, Albert E. Marshall, Walter A. Schmidt, M. C. Whitaker and Alfred H. White.

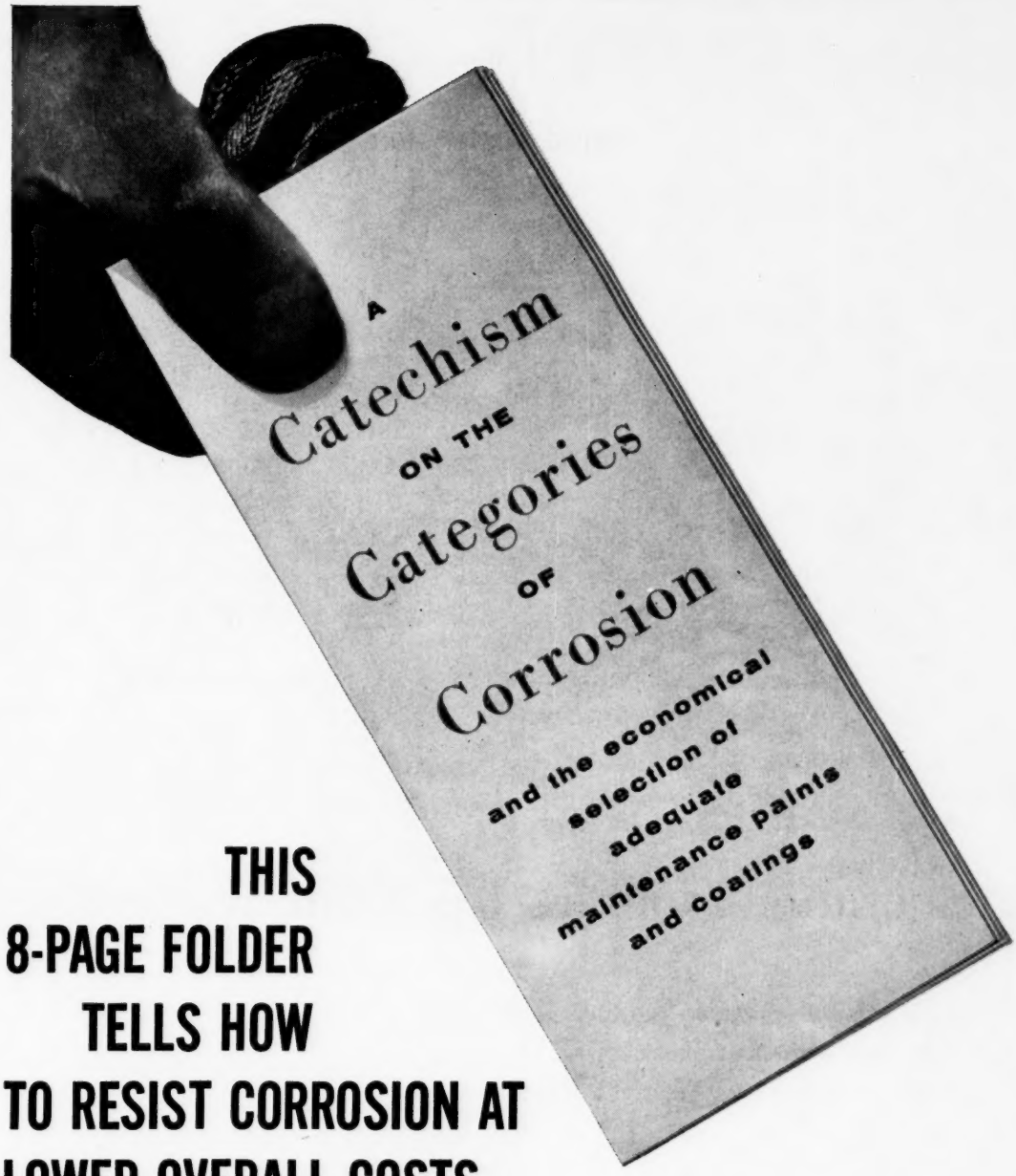
Committee secretary for that first award in 1933 was Sidney D. Kirkpatrick, then editor of *Chemical & Metallurgical Engineering*, now editorial director of *Chemical Engineering* and *Chemical Week*. Sid has been closely identified with this award ever since, presiding over the festivities and personally handling many of the necessary details.

Sid is retiring at the end of this year, after 38 years with McGraw-Hill. His many contributions to the advancement of the chemical engineering profession have earned him numerous honors: Clarkson University and Brooklyn Poly have awarded him honorary doctor's degrees; Society of Chemical Industry chose him as Chemical Medallist in 1945; American Institute of Chemical Engineers presented him last year with its first Founders Award; and just last month, Chemical Market Research Assn. paid homage to Sid in selecting him for its Memorial Award.

But such tributes as these—important as they are—are prone to be forgotten much too soon. We feel that Sid deserves a more lasting recognition—one which will honor his life and works for many years to come.

To that end we dedicate the new name by which our biennial award will henceforth be known: The Kirkpatrick Award for Chemical Engineering Achievement.

WALLACE F. TRAENDLY
Publisher



THIS 8-PAGE FOLDER TELLS HOW TO RESIST CORROSION AT LOWER OVERALL COSTS

If you have anything to do with maintenance of equipment or structure, or with the costs that result therefrom, this folder may be extremely useful to you. It gives a rational basis for paint and painting specifications, and tells how all surface and area exposures can be classified into the Four Categories of Corrosion.

As in all other phases of engineering, both underdesign and overdesign of maintenance painting carry economic penalties. Either one will show up sooner or later on the overall cost sheets. Although Hercules does not make any finished paints or coatings, we have had over twenty-five years' practical experience with Parlon® chlorinated rubber, a key material for corrosion-resistant and high-performance maintenance paints.

This booklet has been written with this background of experience. Write for your copy.

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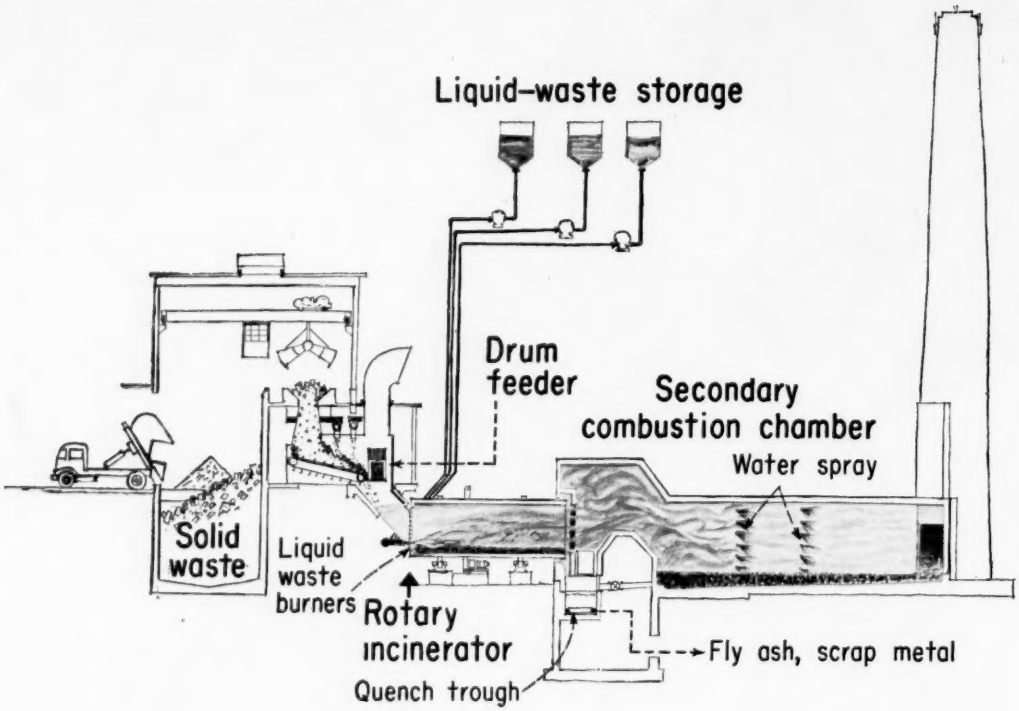


Incineration Gobbles Up Plant Wastes

Liquid wastes make up the fuel that fires a rotary incinerator which, in turn, swallows everything but the kitchen sink.

"We believe incineration—safe, efficient incineration—is the only answer to disposal of major quantities of chemical industry wastes." So runs a sentence from a movie script describing Dow Chemical's recently-completed $2.25-million incineration plant in Midland, Mich.

Dow has gone a long way to verify its contention. Everything that will burn is disposed of by burning.

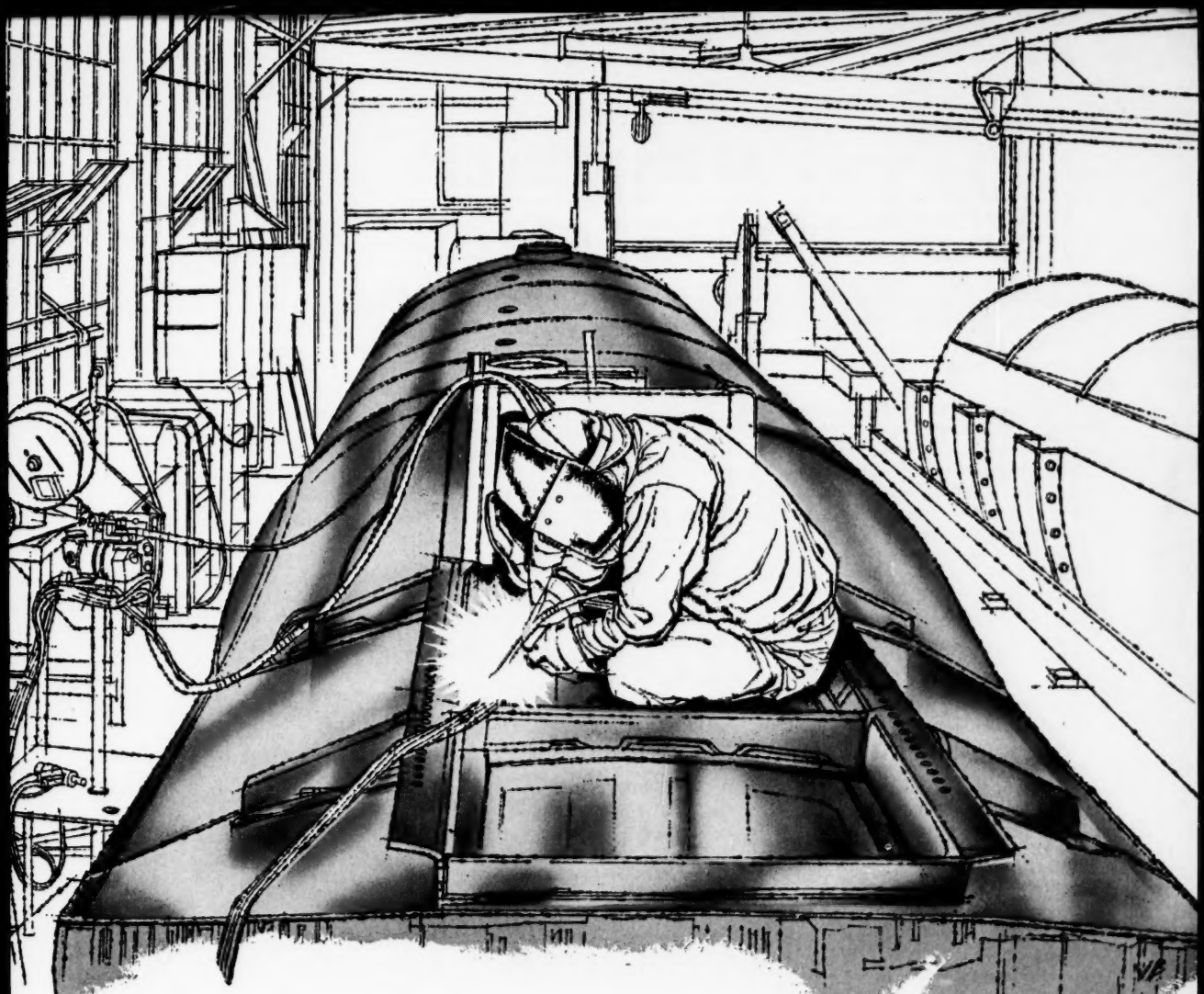
Using a stationary furnace for combustible liquid chemical wastes and a rotary kiln for solid wastes, Dow's engineers polish off a stream of unruly material—toxic, explosive, smelly—without adding measurably to air pollution or plant hazards.

▶**Waste Against Waste**—In a sense, the incineration plant plays one waste against another. First of all, Dow reserves perhaps 15% of all liquid waste in order to fire the rotary kiln, a greatly modified municipal-type incinerator, 13 ft. in dia. and 35 ft. long.

Reasons for this go far beyond economy. By firing the kiln with highly combustible liquids, Dow gets high, even temperatures—close to 2,000 F.—throughout the kiln. This insures complete combustion of burnable materials within the kiln and, consequently, a clean stack effluent. And liquid-waste burning keeps the kiln hot when no refuse is moving through it.

Plastics are especially stubborn in this respect. Few furnaces can satisfactorily incinerate these materials, for they melt and burn at the same time, the unburned viscous material dropping through grates and hardening on cooling.

Thus rotary, rather than grate-type, equipment is called for. Melting plastic mingles with



Formula for Success

The formulation of a stainless steel alloy requires as much precision as any chemical compound. All the care exercised in the selection of a particular alloy can be nullified by variations in the analysis specified.

During fabrication, for example, slight differences in chromium-nickel: carbon ratios can cause changes in microstructure which lead to early failure.

That's why it is safer to specify J&L Consistent Quality Stainless Steel. J&L leads the industry in melt shop standards for stainless steel—the point where quality starts, **and longer service life begins.**

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the ash or sticks to the side of the kiln and burns completely.

Yet in the absence of the really hot flame the liquid-waste burners produce, these plastics and other high-Btu. hydrocarbons would burn incompletely and produce a dense black smoke unacceptable for discharge.

▶**Enter Garbage**—Slag and ash are necessary to provide a good surface for tumbling in the rotary kiln. However, very little slag and ash result from combustion of plastics and liquid chemicals. But "refuse and garbage does beautifully" as a substitute —and Dow has the whole city of Midland to draw from.

Refuse also helps minimize the radiant heat problem posed by burning 8 gpm. of liquid chemicals in the kiln.

▶**Big Job**—Dow's wastes are both fractious and bulky: some 400,000 gal./mo. of liquid still residues, washes, slurries and contaminated liquid products; more than 1,700 drums and other containers of semi-liquid and solid wastes per month; almost 17,000 cu. yd./mo. of other refuse, including large amounts of plastics.

No wonder the incinerator tandem is designed to handle 81 million Btu./hr. of liquid wastes —we'll call them "tars" from now on—and 60 million Btu./hr. of solid wastes.

Now let's look at the operation in greater detail.

Liquid wastes, trucked from all areas of the plant, are dumped into 15 agitated tanks with a total volume of 110,000 gal. Two tanks receive high-Btu., low-ash tars for burning in the powerhouse. Others take solvents and water slurries. Still others, heated and insulated, are used for storing and blending hot phenolic tars above 80 C.

▶**Careful Collection**—An up-to-date catalog of all tars on hand and on the way helps keep everything straight. Some tars must be kept hot, some contain high percentages of water and must be kept away from, say, phenolic tar at 120 C.

Each tank has a large explosion vent behind its loading hopper. An electric eye in front of the tar tanks actuates bells when trucks back in to dump their loads.

All solid wastes—except full drums and extremely hazardous materials—go to an 800-cu.-yd. refuse pit. There a crane mixes the stuff and carries it to an incinerator feed hopper. From there the solids move along a conveyor into the feed chute for the kiln. When feed contains a high proportion of plastics, the conveyor slows to permit maintenance of high combustion temperatures in the kiln.

Sprinklers, manually controlled from the operating floor, are located around the refuse pit, in the feed hopper and above the feed conveyor. And the feed chute is cooled to prevent ignition of material within it. A large vent over the feed chute relieves pressure from explosions within the kiln.

▶**Drums, Too**—Explosive or toxic materials are fed to the kiln in their containers—whether they be fiber or metal drums, cans or bottles. The drum feeder works this way: First the conveyor is stopped and a drum grid (or elevator, you might say) is raised in the feed chute. Outside the chute, the drum is placed on a movable pallet. The operator steps behind a metal shield, pushes a button which opens a guillotine door, the pallet with the drum moves into the feed chute, and the door closes. The pallet retracts, leaving the drum on the grid platform. Then the grid lowers the drum to a sliding position in the feed chute and releases it to the kiln.

Small quantities of very toxic or explosive wastes are dropped down a small hole in the floor above the feed chute.

▶**Tars Heat Kiln**—Tars are fed from storage to horizontal, low-pressure burners at both sides of the feed end of the kiln. (Most of the tars are, of course, burned in the stationary incinerator—a conventional suspended, wall-type furnace). Light tars or waste solvents are usually burned at the burner tips, with the heavy tars being forced out into the kiln where refuse combustion takes place. This minimizes radiant heat effects on the feed chute and seal plate.

Gases pass through a turbulent secondary-combustion chamber and then through water sprays, which knock down fly ash, to the 200-ft. stack. No secondary fuel or afterburners are required. Secondary air and increased detention time in the turbulent zone insure complete combustion of the smoke.

Unburned residue—including drum fragments, tin cans, slag and ash—moves out of the kiln and drops into a quench trough holding 3-ft. of water. Water used to knock down fly ash is sluiced to the quench trough as well. A conveyor at the trough's bottom picks up settled material, carries it up an incline and across a bar screen which separates metal from ash.

Data Now Revealed On Russian Solar Rocket

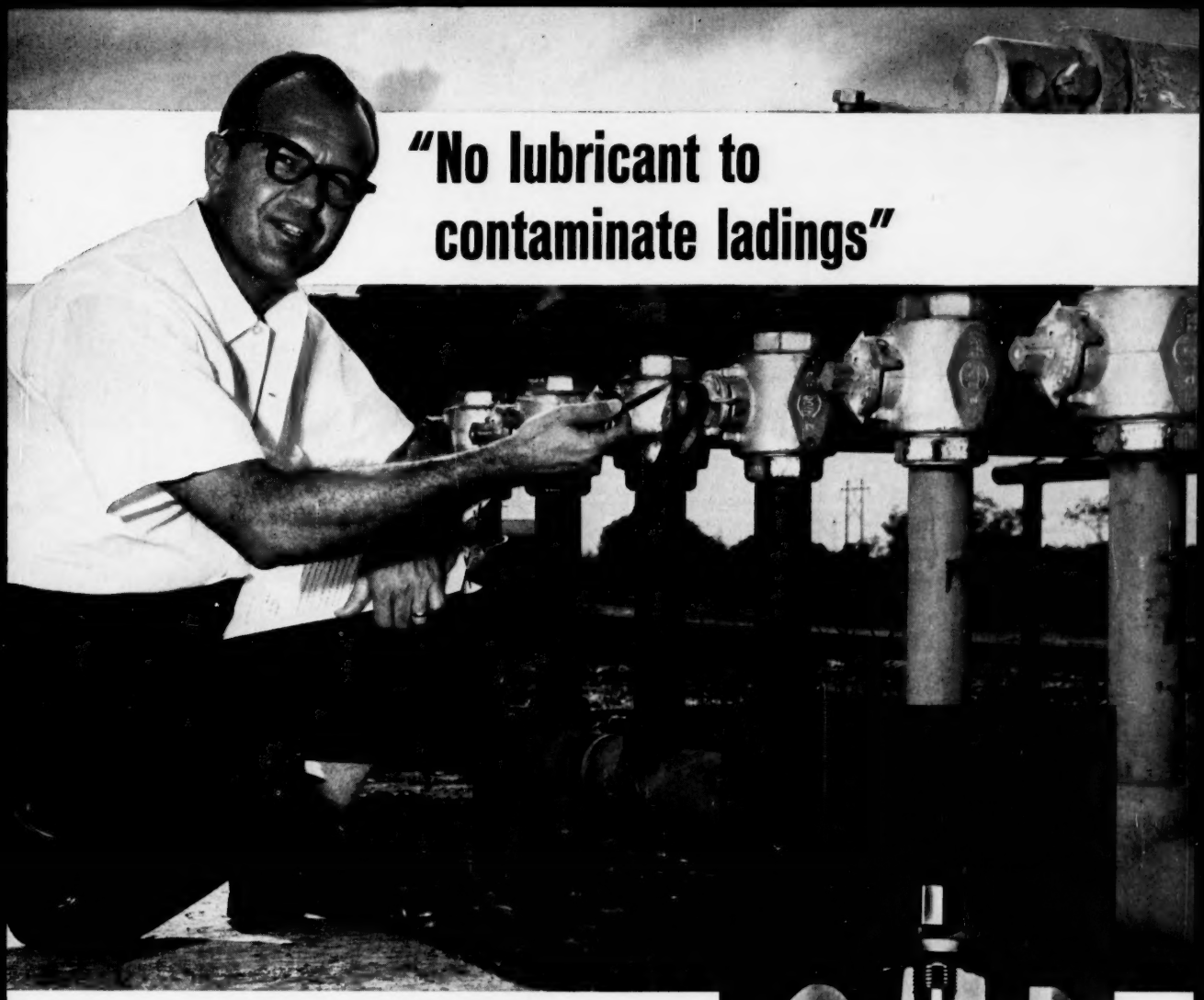
Some rocket design and propulsion details are now gleaned from a Czechoslovakian aviation magazine regarding the Russian solar rocket, Mechta, launched early in January this year.

Three-stage Mechta used, as first stage, an intercontinental ballistic missile with two auxiliary solid-fueled rockets, developed about 300 tons thrust at sea level. Second stage was rocket motor from intermediate-range ballistic missile. Third stage was of special design. Hydrocarbon liquid fuel contained a boron additive; oxidizer was liquid oxygen.

▶**Propulsion System** — Rocket motors were equipped with mixing chambers in front of the combustion chamber, making it possible to reach in the latter a pressure of 350 psi., dropping to 10 psi. in the exhaust nozzle.

Despite a working temperature of about 6,100 F., wall temperature of combustion chambers and exhaust nozzles was lowered to 1,140 F. by a cooling system. Coolant was rocket fuel itself, circulated through channels around the combustion chambers. Thermocouples measured chamber wall temperature and regulated fuel flow through channels.

Fuel pumps in all three stages were driven by steam turbines. Burning gases from combustion chambers produced the steam. At blast-off, a special compressor was used.



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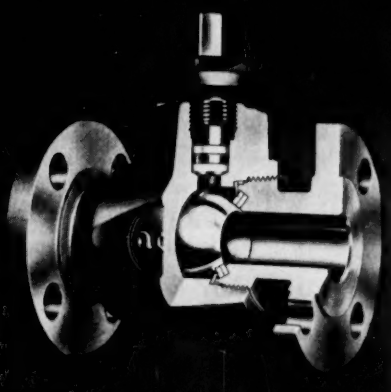
ACF® non-lubricated Ball Valves

ACF Ball Valves are specially designed for ladings that require absolute purity. There is no lubricant, no possibility of contamination. The chrome-plated ball is suspended between Teflon seats under compression for leakproof sealing.

A quick quarter-turn operates this rugged valve. Specify it. You'll get efficient, economical performance. *Available at leading supply stores everywhere.*

Service-proved for 4½ years with such ladings as: high octane gasolines • alkalis • caustics • liquefied petroleum gases • butane • propane • synthetic fuels • penetrating gases • alcohol.



ACF non-lubricated Ball Valves feature full bore conduits, Teflon stem gaskets and seats that are sealed from the lading flow.

Working Pressures: In carbon steel with ASA ratings of 150 and 300, and a few sizes in ASA 600; in semi-steel with 200 and 400 pound ratings.

Sizes: ½" through 6".

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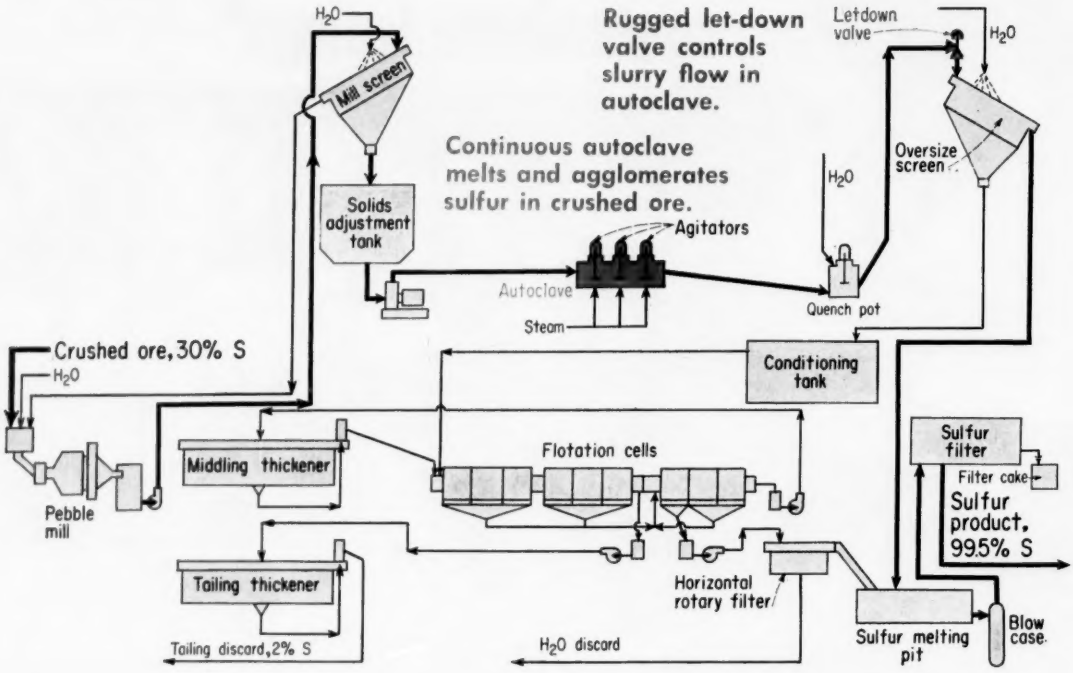


Frasch Principle Wins Ground-Level Job

With continuous autoclaves, new process uses Frasch principle to recover elemental sulfur economically from ore containing as little as 30% sulfur.

Technology borrowed from two proven processes now opens up a new source of sulfur.

Using continuous autoclaves originally developed to extract cobalt and nickel from ores chemically, Chemical Construction Corp., New York, applies the Frasch hot-water principle to melt and recover sulfur contained in low-grade ore.

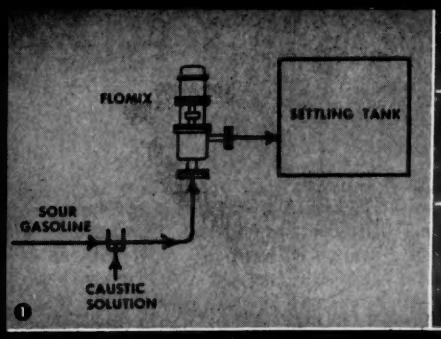
First proven on a commercial scale in a plant at Cali, Columbia, process is well launched in a second plant just started up at Volcan Overo, Argentina, high in the Andes.

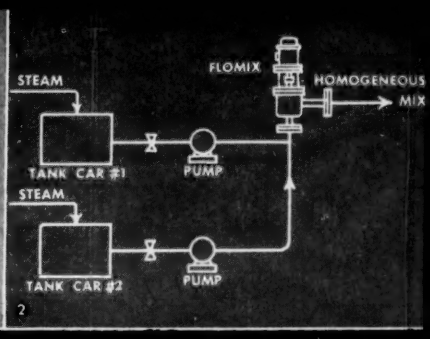
Treating 208 tons/day of ore, the Argentina plant recovers at least 90% of the sulfur content to produce 50 tons/day of 99.5% sulfur. Applied to the same ore, conventional processing would recover only about 65% of the sulfur, would have to process half again as much ore for same sulfur output.

▶**Why Use This Process?**—Where does this process fit in the over-all balance between the Frasch process, roasting of pyrites and recovery from sour gas?*

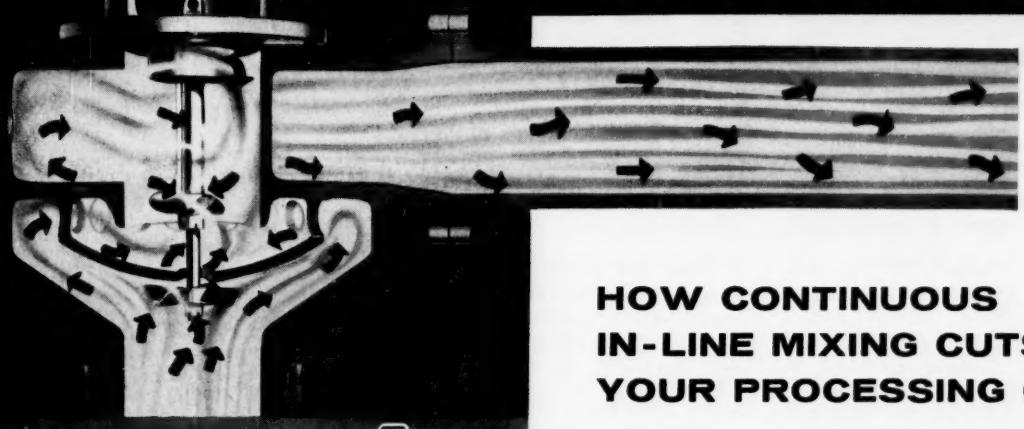
Chemico feels that continuous autoclaving makes elemental sulfur from low-grade ores a whole lot more attractive than transporting it a long distance from existing sources. Even in the U. S. A. with its heavy cache of Frasch sulfur, Chemico visualizes situations where 100-ton/day-or-more installations would pay off.

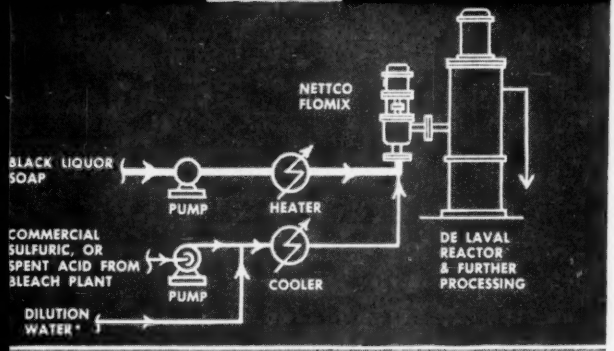
* At 5.8 million long tons/yr., Frasch sulfur from the U.S.A. and Mexico supplies almost as much of the world's sulfur as sulfur from pyrites. Now at a 1.2-million-long-ton/yr. level, elemental sulfur from Canadian and French sour gas is growing fast, while output from the older sources is declining.

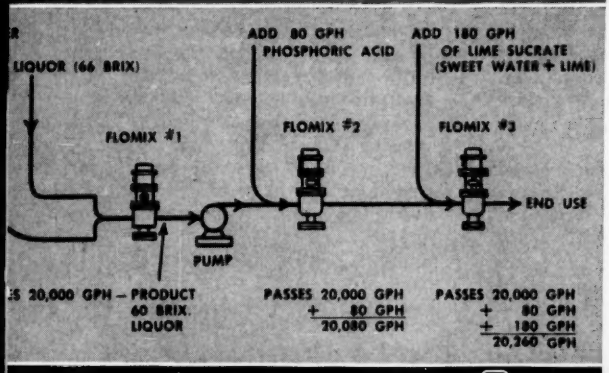


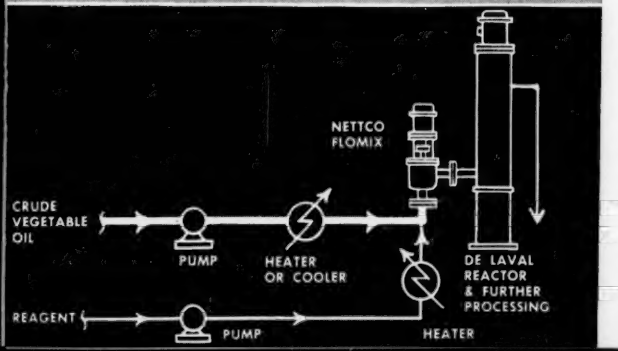


Improved Processing through Engineered Agitation






LIQUOR (66 BRIX)
ADD 80 GPH PHOSPHORIC ACID
ADD 180 GPH OF LIME SUCRATE (SWEET WATER + LIME)
FLOMIX #1
FLOMIX #2
FLOMIX #3
END USE
PUMP
20,000 GPH – PRODUCT 60 BRIX LIQUOR
PASSES 20,000 GPH + 80 GPH 20,080 GPH
PASSES 20,000 GPH + 80 GPH + 180 GPH 20,260 GPH



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Process lends itself to automation, would cost 25% less for labor in the U. S. A. than conventional ore processing. Since processing equipment is so much smaller, such unlikely, but possibly convenient, plant sites as mountainsides become practical.

▶ **On Top of World**—As a matter of fact, the Argentine plant is located 8,000 ft. up on a mountainside. Ore mined at 15,000-ft. elevation descends by 7.5-mi. aerial cableway to mill for processing.

Ore is reduced by two-stage crushing followed by wet grinding to pass a 28-mesh screen. After adjustment to 30% solids content, slurry is pumped into autoclave.

▶ **Sulfur Melts**—Flowing continuously through autoclave's three agitated compartments, slurry is heated to 266 F. and 55 psig. by steam injection in bottom of each compartment.

As a result of the heat and agitation, the sulfur particles meet and separate from the gangue, forming globules of liquid sulfur. Some of these globules collide during agitation and agglomerate, making them larger than the gangue particles.

The degree of separation and agglomeration is a function of several factors, including pH of the slurry, temperature, amount of agitation, character of the ore and retention time at elevated temperature.

▶ **Solidify and Separate**—Hot slurry flows from the autoclave into a quench pot where cold water injection cools it. The sudden cooling solidifies the separated molten sulfur particles. Reducing temperature in this fashion also permits pressure release later without flashing the slurry.

Cooled slurry is throttled to atmospheric pressure through a motor-operated slurry valve controlled by the slurry level in the quench pot.

Next, cooled pulp flows to 28-mesh screen which separates about one half of the original sulfur content as a 98% pure product. This material goes directly to sulfur-melting pit that precedes final filtration.

Underflow from the screen goes to a flotation circuit for separation of the smaller sulfur particles from gangue. Flotation concentrate, containing about 93% sulfur, is dewatered on a horizontal filter and discharged to sulfur-melting pit.

Liquid sulfur from melting pit is pumped through pressure filter for removal of gangue to increase purity up to 99.5% level. Filter cake, containing about 50% sulfur, may be recycled to pebble mill for reprocessing, or may be sold as is.

▶ **Key Engineering**—Features in the engineering design of the process that account for its operating success are the autoclave and the let-down valve. (*Chem. Eng.*, Jan 26, 1959, p. 130).

Valve operates automatically to maintain proper flow rate of slurry through autoclave. Constructed of ceramic and stainless steel materials, valve can withstand effects of pressure, temperature, corrosion and erosion.

Studies Now Underway on Unique Coated Powders

Seeds plus salts plus hydrogen may soon act as starting materials for fabrication of improved nuclear fuel elements.

Battelle Memorial Institute is currently running pilot studies on processes for fluidized-bed deposition of tungsten, niobium or chromium on micron-size "seed" materials such as uranium dioxide. Atomic Energy Commission has expressed interest in the work, and has started some bench-scale development on its own.

Seed powders to be coated feed into the top of a heated cylindrical reactor. Hydrogen, the fluidizing gas, enters the bottom together with off-gases from a boiler or sublimer containing hot metal-coating salts.

Hydrogen reduction of chlorides is the preferred reaction for deposition of the metal films. However, if the chlorides are not sufficiently volatile, pyrolysis of iodides, carbonyls, alkyls, etc., is an alternate route.

▶ **Applications**—Fabrication of fuel elements via rolling or extrusion of the metal-coated ceramics could eventually eliminate the need for expensive cladding techniques. It is believed that such elements would exhibit improved fission-product retentivity, thermal conductivity and mechanical strength.

Applications for the coated powders most likely will not be limited to production of nuclear fuels. Battelle predicts that atmosphere re-entry problems may find a solution in heat sinks made from appropriate coated-powder systems. And there are definite possibilities for low-cost manufacture of catalysts by film deposition of catalytic agents on support powders. Co-deposition of multicomponent catalysts may also be commercially feasible.

NEWS BRIEFS

Polypropylene: AviSun Corp. has now brought on stream its 20-million-lb./yr. plant at Port Reading, N. J., to produce crystalline and highly isotactic polypropylene. At this time, AviSun offers two commercial grades: general purpose for injection molders, a grade for extruding into monofilaments and fibers. New plant is a converted polyethylene unit of Koppers Co. AviSun is building another plant near New Castle, Del., to produce film and fiber.

Fatty alcohols: Continental Oil Co. has selected Lake Charles, La., as the site for its 50-million-lb./yr. plant to make straight-chain primary alcohols from petroleum hydrocarbons (*Chem. Eng.*, Oct. 20, 1958, pp. 59-61). In the past, such alcohols have been produced commercially from natural oils and fats. In Conoco's modification of basic Ziegler process, it starts with ethylene, hydrogen and aluminum.

Thorium oxide: Sawyer Petroleum Co., Oatman, Ariz., has recently shipped thorium concentrates containing about 30% thorium oxide to Lindsay Chemical Div. of American Potash & Chemical Corp. Sawyer wins concentrates from thorite ore by flotation followed by an acid leach.

Why settle for less-than-perfect blending? when you can put CONTROLLED DISPERSION to work for less than $1600.00*

If you mix dry solids or semi-solids in *any* quantity, an investment of only $1549.00 in this ¾ cu. ft. *intensive* mixer may show you how to save *four times that much* in waste, rejects and reprocessing costs—in the next year or less.

The "LF" model of the Simpson Mix-Muller is manufactured to the same exacting standards as production size Mix-Mullers. It was designed to be used in lab or pilot plant as an economical means of establishing standards for batch composition; testing new formulations and for checking quality control on production mixing operations.

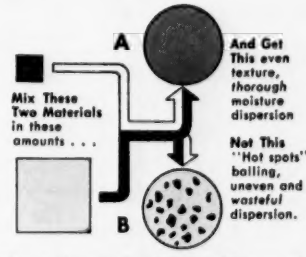
Experience shows, however, that it is most frequently used by prudent processors who want to evaluate the benefits of controlled dispersion *for themselves*, before they invest in full-scale mulling equipment. The fact that *few* "LF" machines are ever disposed of but *many* enthusiastic converts to the mulling principle of controlled dispersion are made, is evidence that the "LF" is a wise and *useful* investment for small, or large scale operators.

Write for a list of users of the versatile "LF" Mix-Muller . . . Or, for details on a confidential *mulling* survey of your product conducted under the strictest laboratory conditions.

- Unit, ready to go, as above, FOB Chicago $1549.00*
- Same with #302 or 304 stainless steel pan and all interior mixing components FOB Chicago $2995.00*

*Prices quoted are for domestic shipment only.

Model "LF" Mix-Muller has capacity of ¼ to ¾ cu. ft. Comes equipped with 1 HP motor and starter, V-belt drive, removable dust hood, crib and muller scrapers, liquid additions funnel, integral base for bench mounting and 4 pipe legs for floor mount. No foundations necessary. Has machined crib and mullers; discharge is automatic, by bottom door.


A
B
Mix These Two Materials in these amounts . . .
And Get This even texture, thorough moisture dispersion
Not This "Hot spots" balling, uneven and wasteful dispersion.

Here's how *controlled mulling* works:

Diagram shows comparative results of blending a minute amount of one material with large amount of another material in (A) MIX-MULLER and (B) conventional mixer. Savings in raw material, reprocessing time and quality of finished product are the outstanding *rewards* of mulling your product.

P-259R

See our advertisement pages 1263-1266 **C E C** *for more details*

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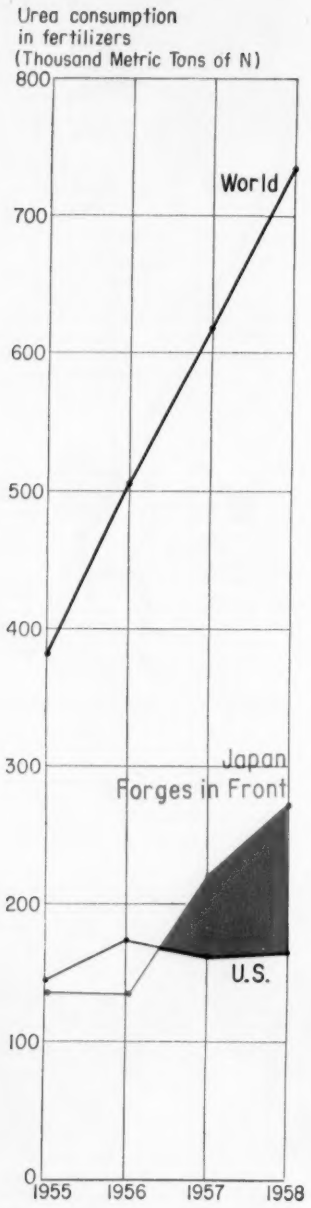
GOING: Mix is wetted, dispersion of coating media begins as lumps form.

GOING: Smearing, *spatulate* action breaks up lumps as mulling action disperses moisture.

GONE. Agglomerates almost gone as blending nears completion. Mix is homogeneous, thorough.

Urea Sets Pace for World Fertilizers



Among world fertilizers, the word is nitrogen. Among nitrogen fertilizers, the word is urea.

John A. King, Assistant Editor

In the last five years, Free World consumption of urea in fertilizers has more than tripled, is still increasing from its present near-800,000-tons/yr. level. And although Free World capacity is roughly twice that amount,* urea producers are still building new plants. At least 900,000 tons/yr. of new capacity is projected for the early 1960s.

Japan—which produced 425,000 tons of urea last year and is really wild about urea—will have capacity to produce 605,000 tons/yr. by the end of 1959, and perhaps 785,000 tons in the next couple of years. Japan's urea effort is second only to that in the U. S., whose present capacity of 940,000 tons/yr. is being stepped up to 1,045,000 tons/yr.

But urea is merely the fastest-moving fertilizer chemical in a world-wide shift in recent years towards utilization of high-nutrient, high-nitrogen fertilizers, both solid and liquid.

►**Ammonia Solutions**—Ammonia is grabbing bigger fertilizer markets as a prime constituent of nitrogen solutions for direct application to the soil. For example, consumption of liquid nitrogen fertilizers in the U. S. accounts for more than 55% of total U. S. fertilizer-nitrogen consumption. More than half of these liquids contain ammonia; urea in solution helps to make up the other half.

These two trends—one towards urea, the second towards ammonia solutions—account for much of the anticipated 24% increase in world consumption of fertilizer nitrogen since 1956 (see table, p. 60).

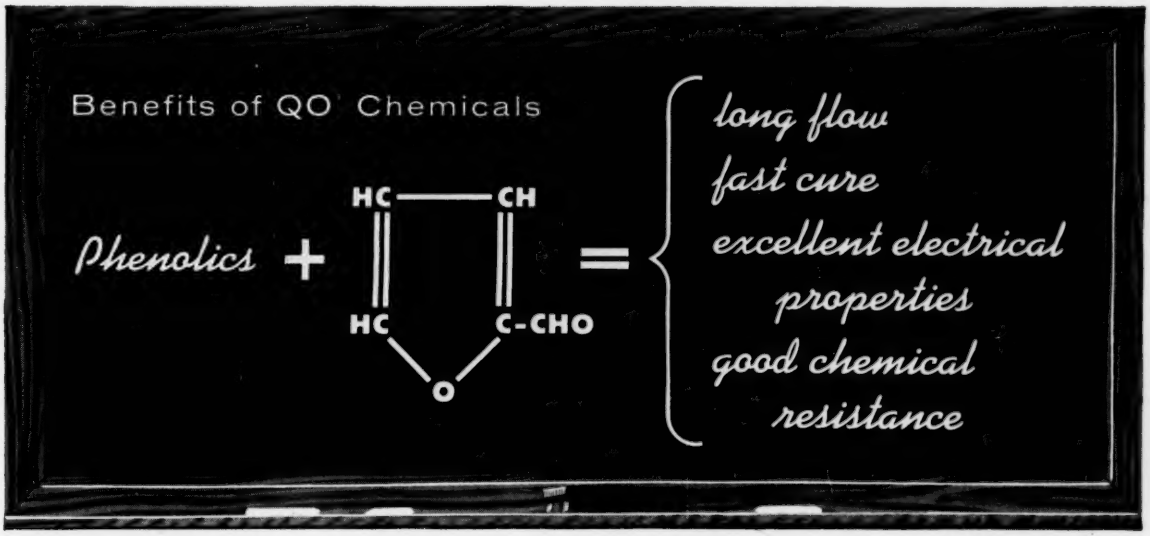
Nitrogen in fertilizers is, in fact, outlegging phosphates and potash, which show consumption increases for the same period of only 17% and 20%, respectively.

Japan's dense population has spurred its urea-capacity expansions, as has the population problem spurred growth in other Asian countries. Development of processes for production of hydrogen from natural gas and fuel oil has enabled these Asian countries, where coal and coke are not readily available, to synthesize their own ammonia.

Too, development of these reforming processes has caused something of a weakening in the linkage of the fertilizer industry to the petroleum chemical industry. At one time, fertilizer producers depended on coal and coking gas as a hydrogen source, and steel-pickling operations for sulfuric acid. But present world breakdown of feed materials for hydrogen production, for ultimate ammonia synthesis, is oriented strongly toward petroleum and natural gas.

►**Urea for Acid Soils**—The downturn of ammonium sulfate

* Total Free World capacity for urea is actually more than 2 million tons. However, other end uses, like synthetic resins and animal feed, are responsible for perhaps a third of this capacity. Resins account for 40-50% of urea consumption in Europe, for example. Asia's abysmal hunger, of course, puts a higher premium on urea's nitrogen content.



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- Fast cure. Addition of furfural plasticizes phenolics so well that highly advanced fast curing resins become practical for molding compound use.
- Excellent electrical properties and good chemical resistance characterize furfural phenolics.

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Free World's Plant Food: Nitrogen Fertilizer Grows the Fastest

(Thousand metric tons of nutrient)

	Nitrogen (N_2)				Phosphoric Acid (P_2O_5)				Potash (K_2O)			
	Production		Consumption		Production		Consumption		Production		Consumption	
	1956	1959	1956	1959	1956	1959	1956	1959	1956	1959	1956	1959
United States	2,022	2,256	1,873	2,164	2,251	2,467	2,156	2,084	1,699	1,887	1,719	1,796
Europe	3,404	3,474*	2,873	3,474	3,349	3,833*	3,339	4,175	4,600	5,074*	3,450	4,369
Canada & Central America	171	332	100	318	149	44	127	199	0	0	129	178
South America	227	297	116	133	57	86	95	159	16	16	74	91
Asia	813	1,200	1,093	1,374	428	469	447	591	18	80	477	574
Africa	36	54	204	262	242	298	255	322	0	0	58	82
Oceania	18	27	25	41	671	661	686	666	0	0	45	49
Total	**6,691**	**7,640**	**6,285**	**7,766**	**7,147**	**7,858**	**7,104**	**8,343**	**6,333**	**7,057**	**5,950**	**7,140**
% Increase	**14**		**24**		**10**		**17**		**11**		**20**	

*Figures for 1959 estimate not available, 1958 figure used instead.

consumption naturally results from the parting of the fertilizer and steel industries. But it was inevitable even without this factor, because much of our earth's soil is already too acid to permit extensive use of ammonium sulfate fertilizers.

So, urea is moving in where acid fertilizers cannot be used, particularly in the Far East.

Asia has focused its attention on the nitrogen fertilizers for the past five years, and has consumed more nitrogen chemicals than it could produce. European and U. S. nitrogen chemical producers have supplied Asia's needs all these years.

But, the gap between consumption and production of nitrogen chemicals is closing in Asia. This year Asia will produce 1.2 million metric tons of nitrogen fertilizer (on an N basis) as compared to 0.8 million in 1956—thus shaving Asia's nitrogen deficit (production minus consumption) from 290,000 metric tons to 175,000.

U. S. and European producers of nitrogen fertilizers will face increasing competition by producers in pioneering Asian countries, as their new capacity goes on stream. U. S. producers can, however, look to rapidly growing domestic markets. Annual U. S. consumption of nitrogen fertilizers is still spiralling upward, has long since passed the 2.3-million-ton/yr. mark.

▶ **Phosphates Stronger, Too**—U. S. phosphate-fertilizer consumption far surpassed expectations this year. Concentrated phosphate fertilizers, (greater than 40% P_2O_5) in stock at the end of May, 1959 were 60,000 tons below the comparable period last year (42,220 tons in stock at the end of May, 1959). Therefore, to assure continued supply for the next fertilizer season, phosphate producers must churn out extra product this fall and winter.

And although Asian phosphate production has been increased to 469,000 tons/yr., or 9% more than three years ago, U.S. and European producers will continue to supply about 125,000 tons/yr.

▶ **Potash Use Levels Off**—The U. S. potash picture is not so rosy. In line with the world trend, U. S. consumption of potash is leveling off—at about 1.8-million tons/yr. Even in Asia, hopes dwindle of greatly increasing potash consumption, now leveling off at the 570,000-ton/yr. mark.

Leading potash consumer in Asia is Japan, which purchases all of its needs—370,000 tons/yr.—from foreign producers; principle potash fertilizer is potassium chloride.

As foreign potash markets fail to grow, U. S. producers face another threat at home: Russian competition. Opening of the St. Lawrence Seaway now makes possible the relatively-low-cost transportation of Russian potash to central U. S. and Canada. While some U. S. producers boast that Russian potash is an inferior grade, other express real concern.

▶ **Granulation Helps**—General fertilizer consumption trends in the U. S. are reflected by shifts in the use of mixed fertilizers. Granulation of mixed fertilizers and production of high-analysis mixtures are rapidly developing.

These trends are closely linked; most high-analysis fertilizers consist for the most part of soluble salts that tend to cake unless they are granulated. And granulation facilitates smoother distribution in the farmland fields with less dust losses. Tennessee Valley Authority has led much of the development of granulation processes. Today there are more than 200 fertilizer plants equipped to granulate mixtures in the U. S.

▶ **Higher Nutrient Content**—Granulation makes feasible high-nutrient-content fertilizers, thus leads to lower transportation costs/ton of plant nutrient. In the U. S. the trend towards high-nutrient-content mixtures is more pronounced than in other countries, e.g., West North Central States feature 35% nutrient concentration; South Atlantic States, 22% concentration.

The average nutrient content

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in today's mixed fertilizers is 30%. The average $N:P_2O_5:K_2O$ ratio has moved from 1:2:1.1 in 1950 to 2:2:1.7 in 1958, the large increase in nitrogen content following the world trend favoring nitrogen chemicals.

Still another drive towards economy in the U. S. is the increasing use of liquid fertilizers. As mentioned earlier, the key factor in liquid fertilizers in the U. S. is ammonia. Of the total nitrogen fertilizer supplied to the farming industry—2.6 million tons for the '58-'59 season—0.78 million tons was ammonia used in liquid fertilizers.

▶ **Nitrogen, the Globe-Trotter**—In many other sections of the globe, nitrogen chemicals dominate the picture, just as they do the domestic scene.

This is best indicated by the large volume increases in nitrogen-fertilizer consumption in Asia and Europe, and is amplified by the predominance of nitrogen fertilizers in world expansion programs. In Asia, for example, nitrogen production increased by 50% between 1956 and 1958, while phosphate output increased only slightly. Largest increase in nitrogen-chemical output was in Japan, producer of 85% of Asia's nitrogen.

▶ **Asia**—India is focusing its first in a series of development programs on the construction of nitrogen fertilizer plants. Included in the program are an ammonium sulfate plant at Punjab, a urea plant near Bombay, and the world's largest urea plant, to be built at Neyveli. In Madras, a urea plant is planned.

Pakistan already operates a nitrogen plant to eventually supply a 100,000-metric-ton ammonium sulfate plant. Plans include construction of a 100,000-metric-ton ammonium nitrate plant, a 60,000-metric-ton urea plant and another 100,000-metric-ton urea plant.

In the Philippines, nitrogen and superphosphate plants are now in operation. In South Korea, two fertilizer plants are already on stream and one more is under construction. On Formosa, nitrochalk, nitrophosphate and urea plants have just gone on stream.

▶ **Middle East**—Turkey's new nitrogen plant will soon be in operation, and Iran is planning a 100-metric-ton/day nitrogen plant. Fertilizers & Chemicals, Ltd., of Israel has begun producing concentrated superphosphate and triple superphosphate, is now expanding its nitrogen fertilizer plant to a 20,000-ton/yr. capacity.

▶ **South America**—Peru, its guano supplies depleted, is beginning to import nitrogen. In Brazil, nitrogen and phosphate plants have just been completed. In 1957, new fertilizer plants began operation in Puerto Rico and Dominion Republic. Plants have begun operation in Trinidad for production of ammonium sulfate and urea.

▶ **Africa**—Although Africa produces a bare 3% of world consumption, expansion is underway there. Union of South Africa is expanding its ammonia facilities by 70,000 metric-tons/yr. for ultimate conversion to urea. Southern Rhodesia is expanding its superphosphate facilities.

▶ **Europe**—Greece is expanding its fertilizer capacity to satisfy its own needs. Portugal is expanding its ammonia output by 75,000 to 100,000 tons/yr. Spain is erecting a nitrogen plant in the Canary Islands. Netherlands reports increases in capacity for ammonium nitrate-calcium carbonate, ammonium phosphate-nitrate and calcium nitrate.

Are Level Trays Worth the Cost?

Does your company insist on close tolerances for tray levelness in fractionating columns?

You're running up the cost when you do. What's more, you're not getting your money's worth in nine out of ten jobs, according to engineers Dan Lockwood and Wayne Glausser of C. F. Braun & Co. And in many cases you may not wind up with perfectly level trays in the long run, anyway.

Lockwood-Glausser's specific conclusions:

- Trays out of level as much as ½ in. do not significantly affect column performance.
- Factors other than tray installation can affect tray levelness.
- Close tolerances on tray levelness add significantly to column cost—as much as 4%.
- Thus it seems uneconomic to spend money on tray levelness closer than ¼-½ in. for most chemical plant or refinery columns.

To check the effect of tray levelness on performance—and prove their point—Braun engineers ran air-water tests in a 66-in. I.D. simulator column using sieve trays.

Trays were tilted so that outlet weir side was ½-in. above inlet side.

▶ **Weepage Tells Story**—Braun chose weepage (drip from overflow) as the standard for measuring tray levelness' effect on tray performance. Braun claims levelness has little effect on such other performance criteria as vapor velocity (at which the entire bubbling area becomes active) and vapor load.

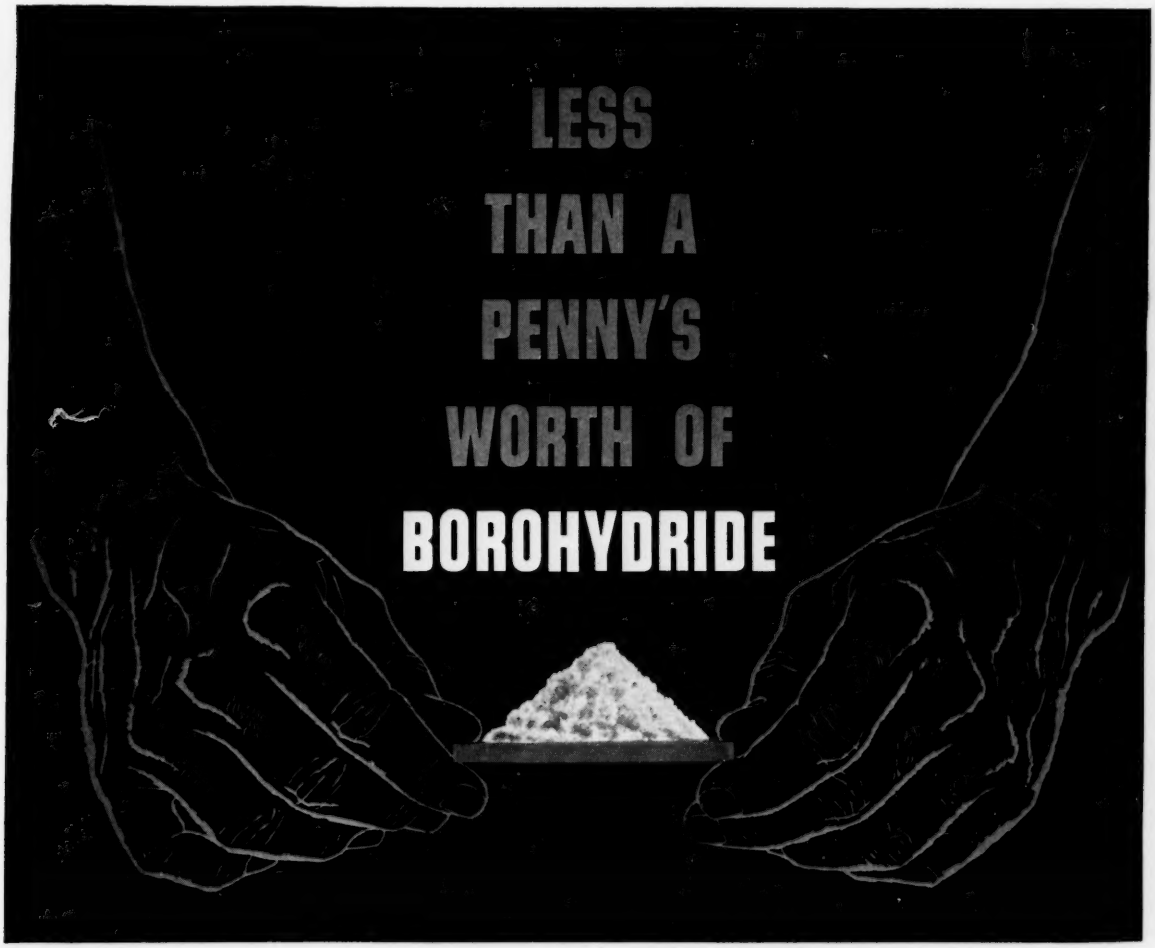
According to Braun, efficiency of bubble cap and sieve trays is relatively independent of vapor load at fairly high vapor rates until appreciable entrainment occurs.

Weepage, according to test data, reaches about the same constant minimum for both tilted and untilted trays. Vapor rate at which this minimum occurs is essentially the same for both trays even at low liquid loadings—2 gpm./inch of weir.

One exception: At very low liquid loadings—under 1 gpm/inch of weir—weepage can represent a relatively large percentage of total liquid flow. Tray levelness becomes important under these conditions—but this requirement exists in less than 10% of the columns in a typical plant.

▶ **Higher Costs** — How much does tray levelness cost? From 2-4% more, based on calculations for two different-sized columns, each at two pressures, and assuming normal out-of-level specifications of ¼-⅜ in. being tightened by 1/16-⅛ in. Actual dollar premium in the examples ranged from $1,000-2,000.

And even though trays are installed perfectly level, other factors—installation of the column, high winds, effect of sun on uninsulated column during field installation of trays—can later throw them out of level.



will "clean up" unwanted aldehydes, ketones, peroxides from a pound of product!

Now, with either MHI sodium borohydride or potassium borohydride it is possible to "clean up" minor amounts (0.5% or less) of these unwanted contaminants effectively by simple contact methods.

This will be especially welcome news if you are now faced with the difficult problem of catalytic hydrogenation, distillation, or complicated chemical treatment to remove residual aldehydes, ketones or peroxides from your product. This is of especial importance if you must maintain color stability in your organic products, if you are concerned with carbonyl poisons in organo-metallic polymerization systems, or if you wish to reduce and inhibit peroxides in ethers. The easy borohydride method adds less than a penny a pound to the material cost of your product and may save more than that in processing costs!

Here are specific products which should respond effectively to borohydride treatment:

- ALCOHOLS
- ESTERS AND POLYESTERS
- AMINES
- NITRILES
- ETHERS AND POLYETHERS
- PENTAERYTHRITOL
- PEROXIDE CATALYZED POLYMERS
- CELLULOSE PULPS
- PEROXIDE BLEACHED ORGANIC MATERIALS *(waxes, etc.)*
- CHLORINATED HYDROCARBONS
- OXIDIZED HYDROCARBON STREAMS
- OLEFINS AND DIOLEFINS

Complete information on MHI sodium borohydride and potassium borohydride is available without obligation. Write today!

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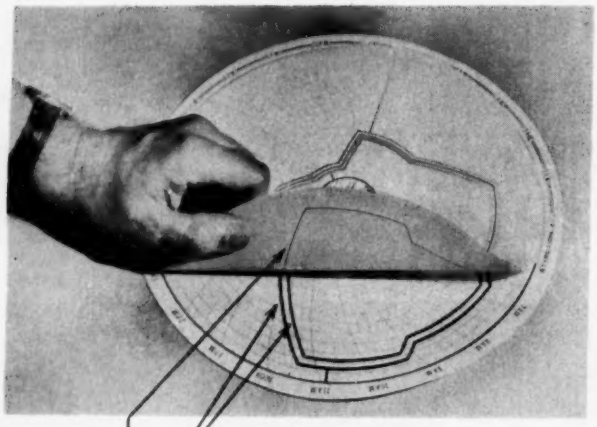

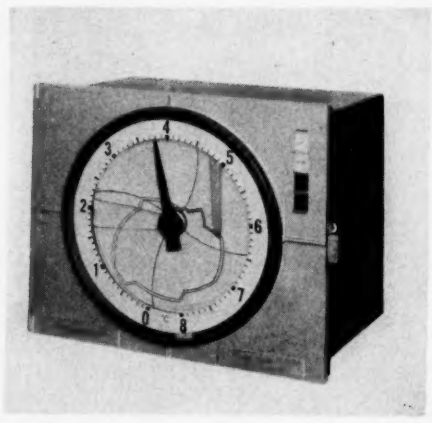

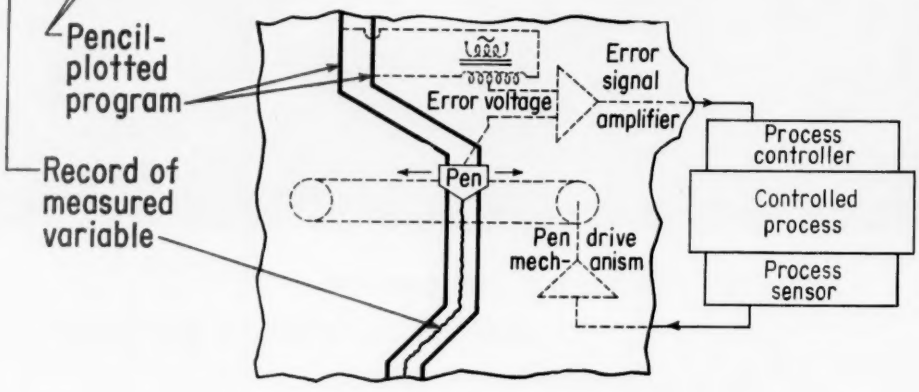

Pencilled Lines Guide New Programmer

To prescribe a process variable's course, take an ordinary graphite pencil and draw a program on instrument chart paper. Then watch results.

Programming-control techniques got a solid push forward two weeks ago when Research, Inc. introduced their PreKorder at the Chicago ISA show. This new instrument "reads" a pencil-drawn program chart, controls a process accordingly, and then superimposes a record of process performance on the same chart for continuous, visual comparison.

Unit design dispenses with several components essential to conventional process programmers—PreKorder has no cams, cam followers or function generators. This elimination gives rise to big savings when programs must be changed. The cost of pencilling or altering a pair of lines on a standard chart is much less than expenses involved in obtaining and instal-

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▶ **Operation in Brief**—A pair of contacts connects the parallel program lines to the two ends of a center-tapped transformer winding. The winding serves as a voltage source for an electrostatic field between the lines.

Acting as a capacitive probe, the recording pen picks up an error signal proportional to any deviation of the pen from its null position midway between the program lines. This signal readjusts the process in the proper direction to ultimately recenter the pen.

Four pushbutton switches, used singly or in combination, provide flexibility of recording, indicating and controlling operation.

Research, Inc. engineers point out that PreKorder's technique of direct error-signal derivation joins the programmer, recorder and the process itself into a compact, closed-loop control system, thereby assuring high over-all accuracy.

▶ **Change Overlays Only**—Because the recording pen-probe senses its position without ever touching the program chart's pencilled lines, clear vellum overlays will serve as surfaces for the inked records. This technique converts any chart into a master program that may be used repeatedly.

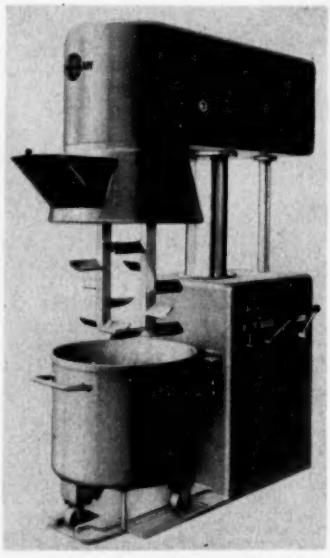
Pencil-drawn boundary lines on the overlays permit introduction of variable programmed process limits. If the process deviates so far from its program that the pen contacts one of these lines, a relay energizes a warning signal or a process shutdown system.

▶ **Preset Process Sensitivity**—By varying the spacing between the plotted program chart lines, operating personnel can program control system sensitivity as well as the controlled variable.

For example, a wide spacing between the lines could reduce sensitivity during periods of possible process instability. Or, when tighter control is necessary, the line spacing can be narrowed.

▶ **Circular or Strip**—PreKorders are adaptable to any process that is compatible with electric control. Monitoring transducers may be either mechanically or electrically connected to the recording pen.

Both circular and strip-chart models are currently available in a broad range of scales, chart speeds, pen speeds and auxiliary control functions. Approximate cost for a strip-chart unit runs $1,200 to $1,500 more than comparable nonprogramming recorder-controllers; circular-chart models add about $2,000 to the cost of conventional instruments.—**Research, Inc., Hopkins, Minn. 64A**



Planetary Mixer

Epicyclic blade movement ups unit efficiency.

Designed to process a wide range of fluid, viscous or pasty materials, a new planetary mixing and kneading machine offers an unusually efficient planetary action, according to the manufacturer.

Two mixing spindles equipped with helically arranged vanes move along the tank wall while rotating at high speed around their own axes. An automatic device raises and lowers the mixing mechanism. Swivel, tilting, runout or stationary tanks are offered in capacities from 1 to 350 gal.—**J. M. Lehmann Co., Lyndhurst, N. J. 66A**

Transducer

For computer control. Has pneumatic output signal.

High-accuracy conversion of a d.c. voltage or milliamp. signal to a pneumatic control signal is function of the new Model 106 Hi-Ac-Tran transducer. Designed particularly for installation between new control computers and existing pneumatic equipment, the unit accepts input ranges from 0.25-2.5 to 1-10 v., and provides output ranges from 0-1.5 to 3-15 psig.

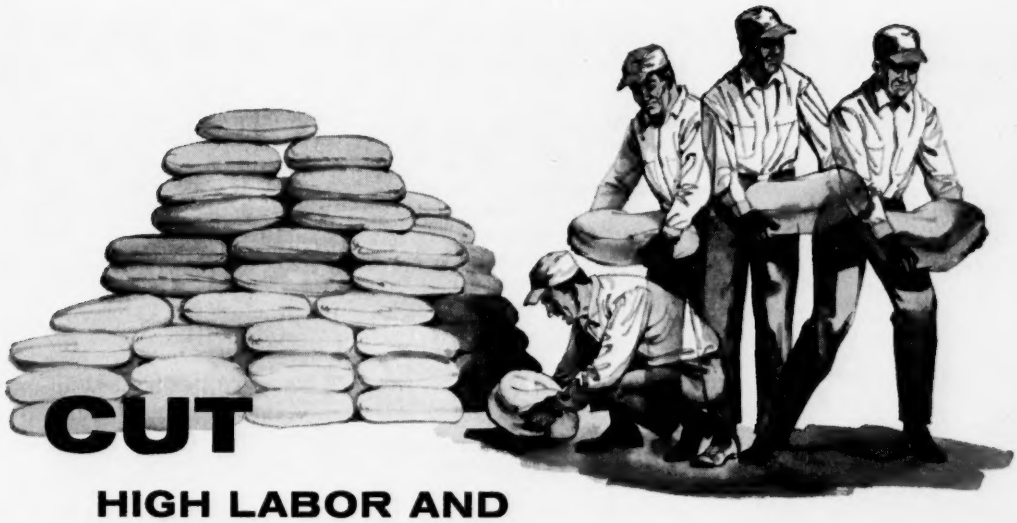
Model 106 comes with standard, weatherproof or explosion-proof housing, and is suitable for ambient temperatures from 0 to 150 F.—**Associated Control Equipment, Inc., Coraopolis, Pa. 66B**

Gas Detector

Contaminants react with clathrate to free Kr-85.

A device applying recent advances in atomic research promises to simplify the task of measuring concentration of nonradioactive gaseous air contamination. The instrument is sensitive in the parts-per-billion range to such gases as O_3, NO_2, ClO_2, etc., either singly or in combination.

Key to operation is a crystalline substance known as a radioactive clathrate. Krypton-85, a radioactive gas, is trapped within the crystal structure of this material. Air to be analyzed passes through a tube holding the clathrate. Contaminants in the air react to release the krypton-85 in an amount proportional to the concentration of the contaminant. The radioactive gas passes into a chamber where a geiger tube



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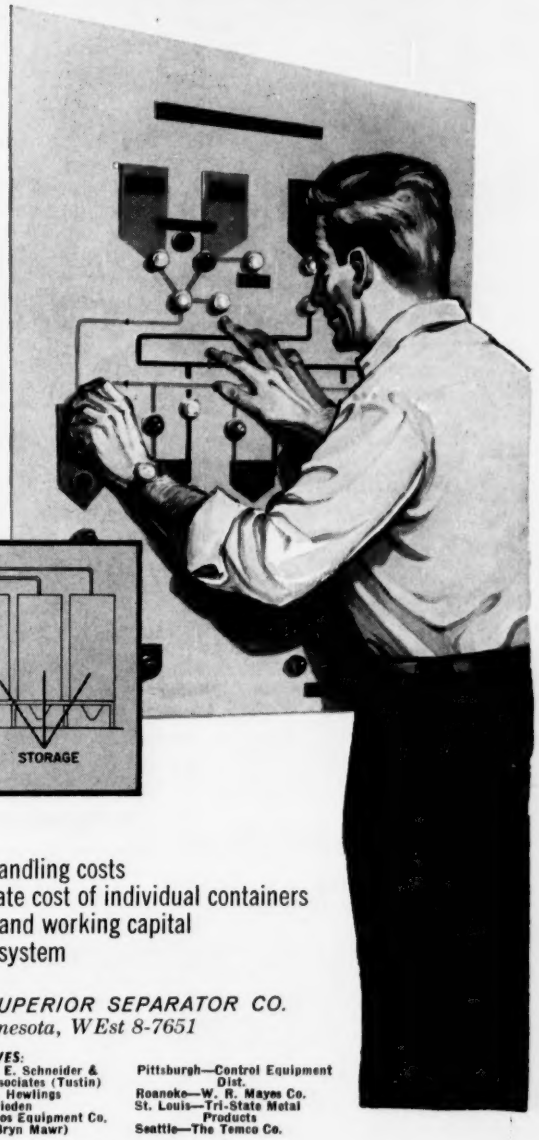

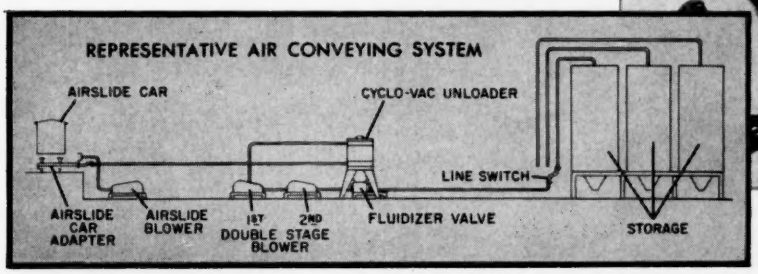

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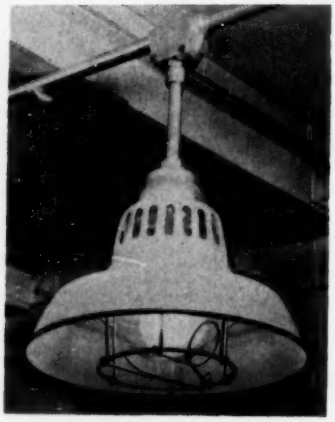
measures the resulting intensity of radioactivity.

Industrial applications will probably include process monitoring of stack gases.—**Tracerlab, Inc., Waltham, Mass. 66C**



Reflectors

Improve distribution of light from fixtures.

Slotted reflectors, available for both explosion-proof and vaportight service, provide improved light distribution for the manufacturer's line of Condulet lighting fixtures. The new units eliminate harsh brightness contrast, improving visibility and seeing comfort.

Up-light of the reflectors brightens dark areas above the fixtures. Fixture operating temperatures are also lowered. Circulation of air through the reflector reduces accumulation of dust and dirt, simplifying maintenance. — **Crouse - Hinds Co., Syracuse, N. Y. 68A**

Heated Rubber Pipe

Stops setup of hard-to-handle fluids in transit.

Electrically heated synthetic rubber pipe may prove ideal for transporting materials such as crude oil, acids and semisolids that require a constant flow temperature.

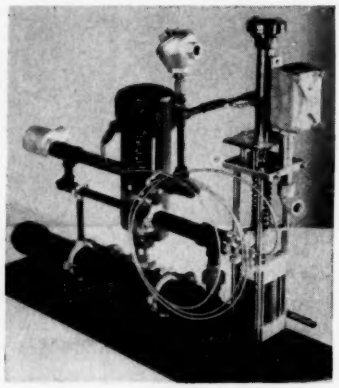
Lightweight and durable, the pipe will receive heat via an imbedded silicone-rubber heating tape, developed by Sunelec, Inc. The pipe itself is made of buna-N hard rubber. A wide variety of liners furnishes desired corrosion resistance.

Available sizes will range from 2 to 6 in.—**Luzerne Rubber Co., Trenton, N. J. 68B**

Valve Test Bench

Portable system can check pressure ratings in field.

Answering the need for a complete, packaged method of pressure-testing valves, a new, portable test bench can handle most valves over a range of 0 to 1,000 psi. Test fluid may be either liquid or gas. One of the two test plates checks ½- to 2-in. screw-end valves and 8- to 10-in. flanged valves; the other adapts to 2½- to 6-in. flanged valves. Separate controls and gages make it possible to test two different valves at the same time.—**Piping Engineering Co., Tulsa, Okla. 68C**



Pipeline Viscometer

Maintains desired measuring temperature.

Norcross Corp. is offering a new pipeline viscometer furnished with two-stage temperature control. Viscosity is measured by a falling piston, and viscosity-time signals are electrically transmitted for recording or control functions.

First stage of the temperature control is self-contained (normally cooling); the second stage (electrical heating) is governed by an electronic temperature controller.—**Norcross Corp., Newton, Mass. 68D**

Batching Control

Entire program wired into a single control element.

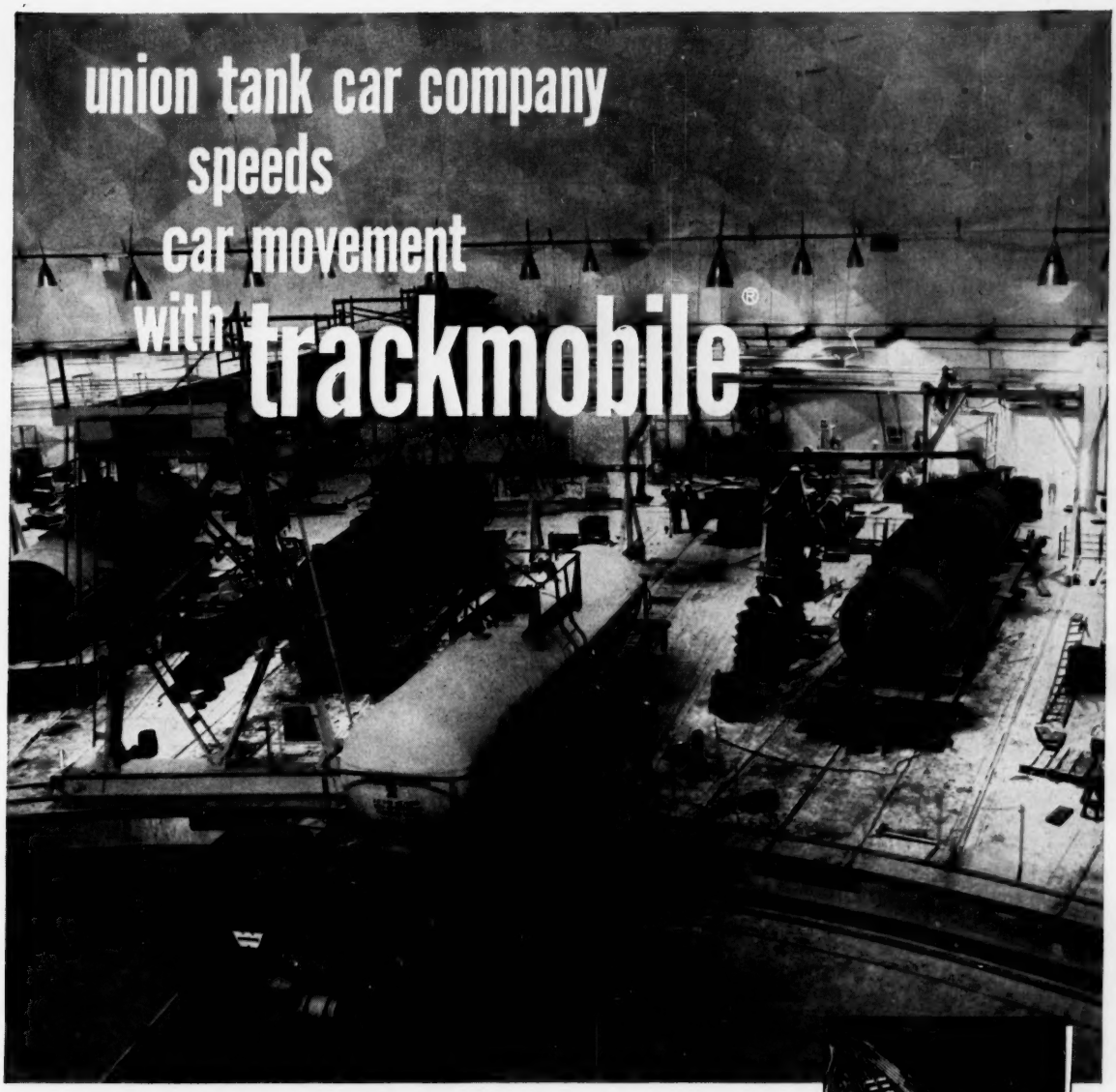
Newest entry into the field of automatic batching control is the "Batchboard" Remocon System. According to the manufacturer, Batchboard eliminates the necessity for manual adjustment of individual weight selectors to obtain desired quantity of each ingredient in the batch.

Plug wires, inserted into the appropriate holes on any Batchboard, set up the desired batch weight of each ingredient for single or multiple scales. Once the unit is wired for a particular formula, it can be used indefinitely without rewiring. As many as 20 ingredients can be controlled by a single program.

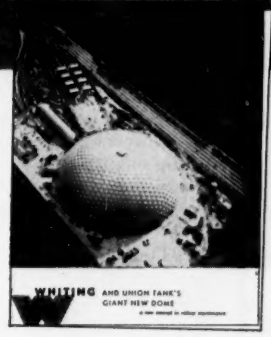
To start batching sequence, the operator flips a switch and inserts the appropriate Batch-

EQUIPMENT NEWS
Continues on . . . **Page 195**

union tank car company speeds car movement with trackmobile®



Many railcars move quickly and efficiently in and out of one of the world's most modern railcar repair shops. A single Trackmobile handles them all at the Union Tank Car Company's giant dome-shaped plant near Baton Rouge, La. Trackmobile pulls them inside the shop and teams up with a Whiting Radial Transfer Table to keep all maintenance stations busy. A most versatile machine, Trackmobile transfers easily from rail to road. Plants throughout the country use it to haul, switch, and spot.



FOR MORE INFORMATION on Trackmobile at Union Tank Car Company write for Bulletin 245. *Whiting Corporation, 15669 Lathrop Avenue, Harvey, Illinois.*

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DEVELOPMENTS . . .

CHEMICAL PRODUCTS EDITED BY FRANCES ARNE

Now Outdoor Painters, Too, Clean Up With Water

For several months past, major paint companies have been coming out with the first water-based latex paints guaranteed to stand up outdoors over primed wood.

Glidden's, called Spred House Paint, was developed for exterior application on wood, masonry, stucco, cement, metal and on asbestos and asphalt shingles.

In addition to familiar advantages of water-based paints such as easy clean-up, the new paints are applicable over damp wood, dry to the touch in 20 min., are remarkably blister resistant.—Glidden Co., Cleveland. 70A

Paper Coatings

Polyethylenes for coating paper, foil, cellophane.

Three new polyethylene paper coating resins — displaying a marked improvement in adhesion and draw-down characteristics as well as a reduction in neck-in, smoking, coating temperatures and polymer build-up at the die—have just been developed. The new resins, which have been field tested and are now commercially available, are designated Petrothene 200-2, 201-2, and 203-2.

	Melt Index	Density
200-2.....	3.0	0.915
201-2.....	5.0	0.915
203-2.....	8.0	0.915

Considerable success has been met in extruding these resins onto a variety of substrates including paper, paperboard, foil, cellophane and others—**U. S. Industrial Chemicals Co., New York. 70B**

Antiozonant

Quadruples crack resistance of truck tire treads.

A chemical just placed on the market, called Flexzone 3-C, has demonstrated it can increase the tread cracking resistance of truck tires more than four times, and hold cracking in passenger car tires down to a point where damage is negligible.

Cracks in passenger car tires are caused by ozone, one of the gases in the air. Most road and outdoor-storage tests on the new product were conducted on the West Coast, where ozone content of air is highest.

Chemically, N-isopropyl-N^1-phenyl-p-phenylene diamine, it performs as an antioxidant as well as an antiozonant.

Hundreds of thousands of miles were run up in the road tests in which 194 heavy duty tires were mounted on commercial trailers. These tests showed that Flexzone 3-C improved tread groove-cracking resistance of truck tires 440% over tires without this chemical. They showed, too, that the chemical guarded against both groove-cracking and flex-crack-

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All manufacturers in the process industries—from producers of pharmaceuticals to producers of petroleum products—depend on filtration. To meet their individual requirements Cuno furnishes a *complete* line of filter types:

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- automatic self-cleaning wire wound
- disposable depth cartridge
- porous metal
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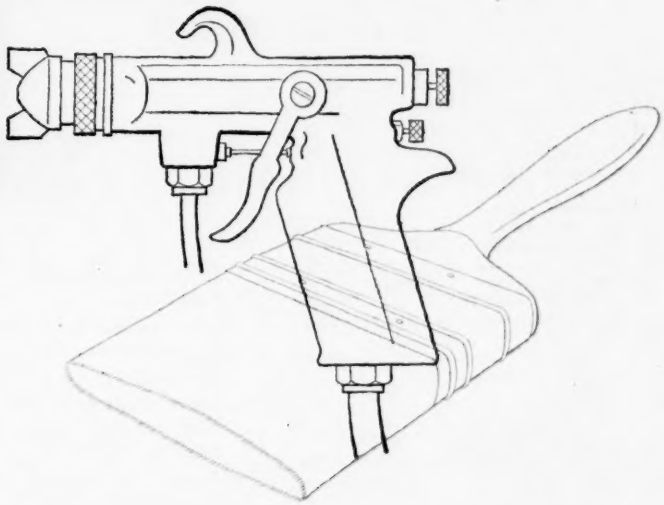

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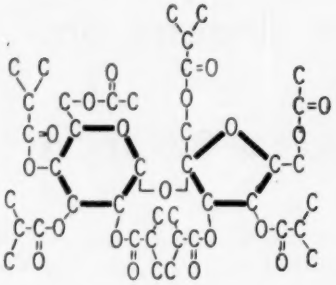
ing in truck tires as well as ozone cracking, a multiple function no single chemical had previously performed.—**U. S. Rubber Co., New York.** 70C



Sucrose Derivitive

Promising modifying extender in a variety of lacquers, melt coatings.

Sucrose acetate isobutyrate, SAIB, is a new chemical compound developed for use in lacquers, hot melts and similar protective coatings. One of the several possible configurations of the SAIB molecule is shown above. It is produced commercially by the controlled esterification of the natural sugar, sucrose, with acetic and isobutyric anhydrides.

In performance, SAIB is a multipurpose compound since in some films it produces a softening effect and in others it maintains the film hardness even after large additions. Therefore, it is characterized as a modifying extender for film-formers and extrudable plastics.

Typical Properties	
Mol. wt. (actual)	832–856
Haze, ppm. (Pt-Co standard)	<1
Acid No.	0.2
Hydrolysis stability, % hydrolized after 96 hr. at 212 F	<0.3
Saponification equiv.	104–107
Refractive Index n 20 C./D	1.4540
Specific Gravity 25/25 C.	1.146
Wt./ Gal., lb.	9.55
Color (Gardner)	<1
Flash point, Cleveland open cup, F.	500
Boiling point, 760 mm., F.	>550
Solubility in Water @ 25 C., %	<0.1

An unusual property of SAIB is its abrupt change in viscosity with temperature or with the addition of solvents. It has a viscosity of about 100,000 centipoises at 30 C. An increase in temperature of only twenty degrees reduces the viscosity to approximately 5,000 centipoises. At 90% nonvolatile ethyl alcohol, it has a viscosity of 750 centipoises at 30 C. Thus for greater handling convenience for the formulator, manufacturer markets two forms: as an unmodified compound, SAIB, for use in hot melts; and as SAIB-90, a low viscosity 90% solution in ethyl alcohol, designed for use in lacquers and similar formulations containing solvents.

Very light color, low volatility, and good thermal stability are basic features of SAIB. Color stability during exposure to heat and ultraviolet light is also good. Hydrolysis stability is excellent —less than 0.2% hydrolyzed after refluxing in water for 4 days.

Toxicity tests indicate that no special handling precautions are necessary.

The electrical properties of SAIB are equivalent to or better than those of many widely used plasticizers. It possesses an especially high volume resistivity. These properties, combined with good thermal and hydrolysis stability, qualify SAIB for use in surface coatings designed for electrical insulation.—**Eastman Chemical Products Inc., Kingsport, Tenn.** 72A

Protective Coating

Prevents scaling on metals during heat treating.

Normally, when a metal is heat treated, scale forms caused by high temperature reaction of metal with oxygen. In some cases it's possible to prevent scaling by heat treating in an inert atmosphere. But this requires expensive equipment. Otherwise, scale must be removed by a time-consuming pickling and sand blasting.

A new coating developed by North American Aviation provides a faster, cheaper method for obtaining a clean metal surface after the heat treating step. Coating is applied by spraying before heat treatment (required for certain metals to harden them, give greater strength). After heating, coating pops off leaving a scale-free surface.

Exact composition of the coating is undisclosed, but it's said to be a clay-based composition with suitable solvent and binder. A patent is being applied for.

It will have application for alloy metals such as stainless, steel, nickel-chromium alloys cobalt alloys, copper alloys. New coating is expected to be interest to metal fabricators and metal processing people,

Newsworthy Chemicals

Page Number is also Reader Service Code Number

Water-based paints now work over primed wood..... 70A
Polyethylene resins coat paper, foil, cellophane..... 70B
Antiozonant quadruples crack resistance of tire treads.. 70C
Sucrose derivative modifies, extends coatings..... 72A
Coating fights scale on metals during heat treating..... 72B
Latex resin will combine with ZnO_2 for coatings..... 74A
MgO ceramic shapes have properties like single crystals 74B
Phenolic resin retains strength at 600 F..... 74C
Insecticide has high efficiency, spares beneficial bugs.... 74D
Tall oil fatty acid excels in color properties..... 74E
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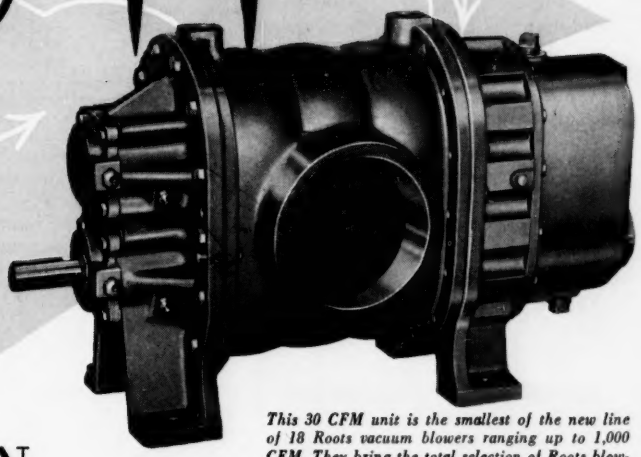


This 30 CFM unit is the smallest of the new line of 18 Roots vacuum blowers ranging up to 1,000 CFM. They bring the total selection of Roots blowers to 54 sizes...with savings for you in every size.

A BIG SELECTION OF SMALL ROOTS VACUUM BLOWERS

Roots-Connersville adds 18 small-volume vacuum pumps to its already extensive line to give you better selection, better performance in limited-volume applications. This new line is designed to handle capacities ranging from 30 CFM to 1,000 CFM, for operation at up to 20 inches mercury vacuum in single stage construction. These units are designed for compounding for higher vacuum service.

Major features of the larger Roots water-sealed units are retained: simple, efficient design without internal valves, no internal contact between moving parts, normal maintenance limited to oil changes, efficient operating speeds and minimum sealing water requirements. The result is more CFM per dollar.

Only Roots-Connersville offers exclusive rotary positive design and such ease of installation in vacuum blowers of this size. They are now available for a wide variety of application in the food, chemical, petroleum, paper, sewage and industrial waste treatment, mining and other industries.

Your nearest Roots-Connersville sales engineer has full details on this new series of vacuum blowers. Or write for a specification sheet and for Bulletin VP-158 covering the larger units.

ROOTS-CONNERSVILLE BLOWER
DIVISION OF DRESSER INDUSTRIES, INC.
1059 Illinois St., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto

especially in aircraft and missiles work.

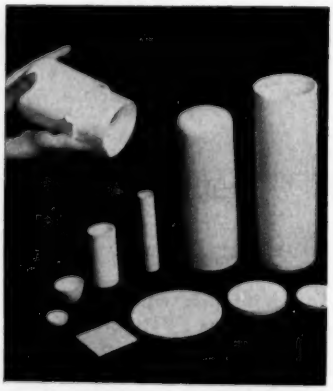
One big claim made for the new product is that it has an effective temperature range of 700 to 3,000 F., which is considered high for metal-treating coatings.—**Navan Products, El Segundo, Calif.** 72B

Latex Resin

Permits addition of zinc oxide to exterior latex paints.

A new latex resin that is compatible with zinc oxide has just been made available to paint formulators. Designated Resyn 25-2243, the compound permits the utilization of zinc oxide to add many of the desirable properties of this pigment in paints. In addition, it offers package stability, until now a problem area when combining zinc oxide with latex formulations.

National Starch developed the resin—a latex, polyvinyl-acrylic copolymer—and in cooperation with American Zinc Institute developed formulations containing zinc oxide.—**National Starch & Chemical Co., New York.** 74A



MgO Ceramic Shapes

Thin-section shapes offer refractory, electrical properties approaching those of single crystals.

A new vitreous, high-purity magnesium oxide ceramic offers on a commercial scale formed shapes having refractory and electrical properties approaching those heretofore obtained only with single crystals.

For metallurgical work, this product combines the high purity of present somewhat porous MgO crucibles with double strength and greater resistance to molten-metal attack.

The well-known electrical characteristics of MgO crystals can now be virtually duplicated in the high-density material, designated Magnafrax 0340.

Properties	
Density, gm./cm.^{3}	3.3 to 3.4
Modulus of rupture, lb./sq. in.	20,000
Compressive strength lb./sq. in.	90,000
Modulus of elasticity lb./sq. in.	36×10^6
Moisture absorption	0 to 0.03%
Thermal expansion	
25 C. to 100C.	10.1×10^{-6}
25 C. to 400 C.	12.1×10^{-6}
25 C. to 600 C.	12.7×10^{-6}
Thermal shock resistance	Fair
Thermal conductivity	0.08 cal./sec./°C./cm.^{2}/cm.

Estimated thermal conductivity is two or more times that of alumina at 150 F.

The 0340 composition is formed into such shapes as tubes, crucibles, plates, discs, bars and rods. —**Carborundum Co., Perth Amboy, N. J.** 74B

Phenolic Resin

Retains strength on prolonged exposure to 600 F. temperatures.

A silane modified phenol-formaldehyde resin, tradenamed Resinox SC-1013, has been developed especially for use with fibrous glass and asbestos reinforcements to make radomes for supersonic aircraft. It retains its strength after exposure to temperatures of 600 F. for hundreds of hours.

The product's high frequency electrical properties and high temperature performance characteristics are said to be several times better than conventional phenol-formaldehyde resins and company believes that it will make important contributions to the development and use of high speed radar domes. — **Monsanto Chemical Co., Springfield, Mass.** 74C

Briefs

Insecticide called Dylox has, in experimental tests at the University of California, killed few beneficial insects while destroying a number of important field crop pests. Chemically, it is dimethyl-trichloro hydroxyethyl phosphonate. By comparison, DDT-Toxaphene mistures, DDT alone, Parathion and Sevin caused marked reductions in beneficial insects.—**Chemagro Corp., Kansas City, City, Mo.** 74D

Tall oil fatty acid called Acintol FA1 Special is said to have exceptionally light color and improved color stability. It is expected to find use in surface coating vehicles, liquid soap products, synthetic detergents, plasticizers.—**Arizona Chemical Co., New York.** 74E

As a fire extinguisher, monobromotrifluoromethane will be used in the Army's hand-operated extinguishers instead of conventional carbon dioxide and carbon tetrachloride.—**U. S. Army, Fort Belvoir, Va.** 74F

Ultraviolet ray absorbing compound useful in cosmetic sun screening preparations has been patented (No. 2,874,-090). Comparative test indicate that the compound, chemically N-salicoyl-p-amino-phenol, is effective in lower concentrations than other screening agents, with concentrations between 0.4% and 5% suggested.—**Heyden Newport Chemical Corp., New York.** 74G

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p 211)

At a Morton warehouse in the South, rock salt is sorted by grade and loaded on barges by conveyor at the rate of six tons a minute.

Only Morton offers salt service to industry everywhere in America

Morton, the only nation-wide salt company, has salt sources, sales offices and warehouses from coast to coast. This means Morton can offer you complete salt service whether you have just one plant or several plants in different states.

Morton produces, refines and delivers nearly 100 different grades of salt to industry for 14,000 different uses. This means you can get expert, *impartial* advice on which grades will do the best job for you.

Morton has two or more sources for any grade of salt you might use. This means Morton is better equipped to make delivery from alternate plants, even under adverse conditions that might otherwise endanger the continuous operation of your plant.

Morton delivers salt by boat, barge, truck and rail. This means you can get fast delivery on a bag to thousands of tons, anywhere in the country.

Morton sales representatives are backed by the services of their own ultra-modern salt research laboratory—the most complete laboratory of its kind in the world. This means you can get complete technical assistance on any problem relating to salt. This service help alone may be worth thousands of dollars to you every year.

▲ *Salt Sources* ▲ *Warehouses* ▲ *Sales Offices*

MORTON SALT COMPANY

INDUSTRIAL DIVISION

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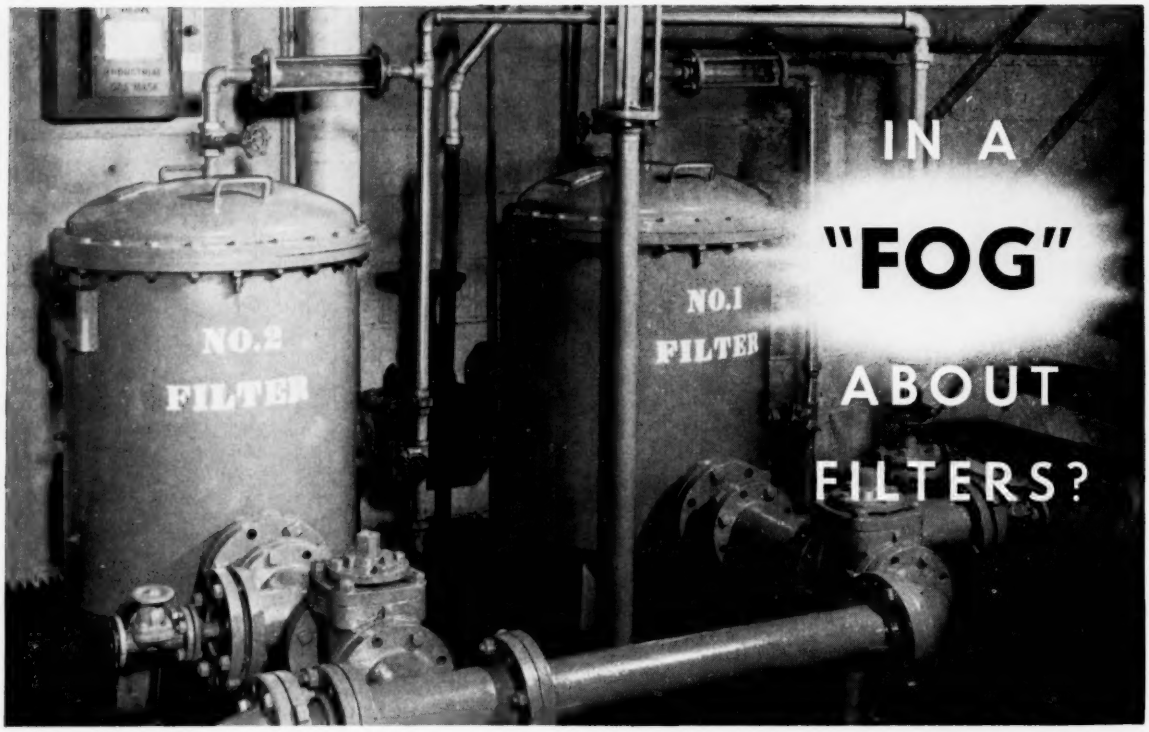


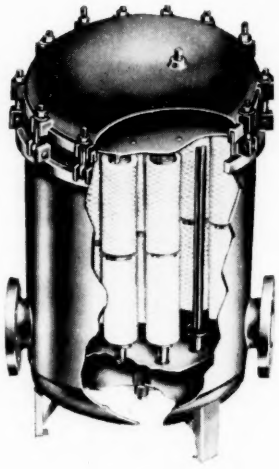
These two Fulflo Filters, each with 110 Honeycomb Filter Tubes, remove micronic particles which were causing haze in chlorinated paraffin produced by the Chlorinated Products Division of Diamond Alkali Company.

Diamond Alkali Clears Up Paraffin Haze with *Fulflo Filters*

If you're in a fog about filters — or product impurities — take a tip from Diamond Alkali. This leading chemical producer achieves gleaming cleanliness of liquid chlorinated paraffins by a final polishing operation with low-cost Fulflo Filters. Highest quality product standards are maintained.

Diamond's liquid chlorinated paraffins have 30 to 150 poise (Brookfield) viscosity, and are clarified at a flow rate of 200-400 gph. Fulflo Filters are available in a wide range of models for high or low flow rate, viscosity, pressure, *p*H and temperature. They provide continuous micro-clarity, by true *depth* filtration, for all types of chemicals, oils, water, and other industrial fluids.

Write for technical literature or engineering assistance to Department CE.



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MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

MICRO-CLARITY AT MINIMUM COST

Fulflo FILTERS — *with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.*

CFC FILTERS — *Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.*

Photo Courtesy E. I. DuPont de Nemours & Co., Inc.

The Chemical Engineer wraps 1,000,000,000 packages a year

Transparent bags for tempting foods, "wraps" big enough to cover your car . . . contributions for convenience and better living made possible by the Chemical Engineer and his technology . . .

The Chemical Process Industries are big — spending over $50 billion for equipment and supplies, turning out over $85 billion in products that range from packaging materials to pickling acids to paints. In this broad spectrum, one essential element—the chemical engineer in all his functions. He designs, builds and operates the plants . . . develops the processes and the products, keeps costs in line. He's your most critical buying influence for raw materials, equipment and services.

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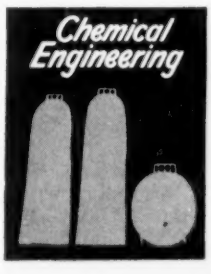
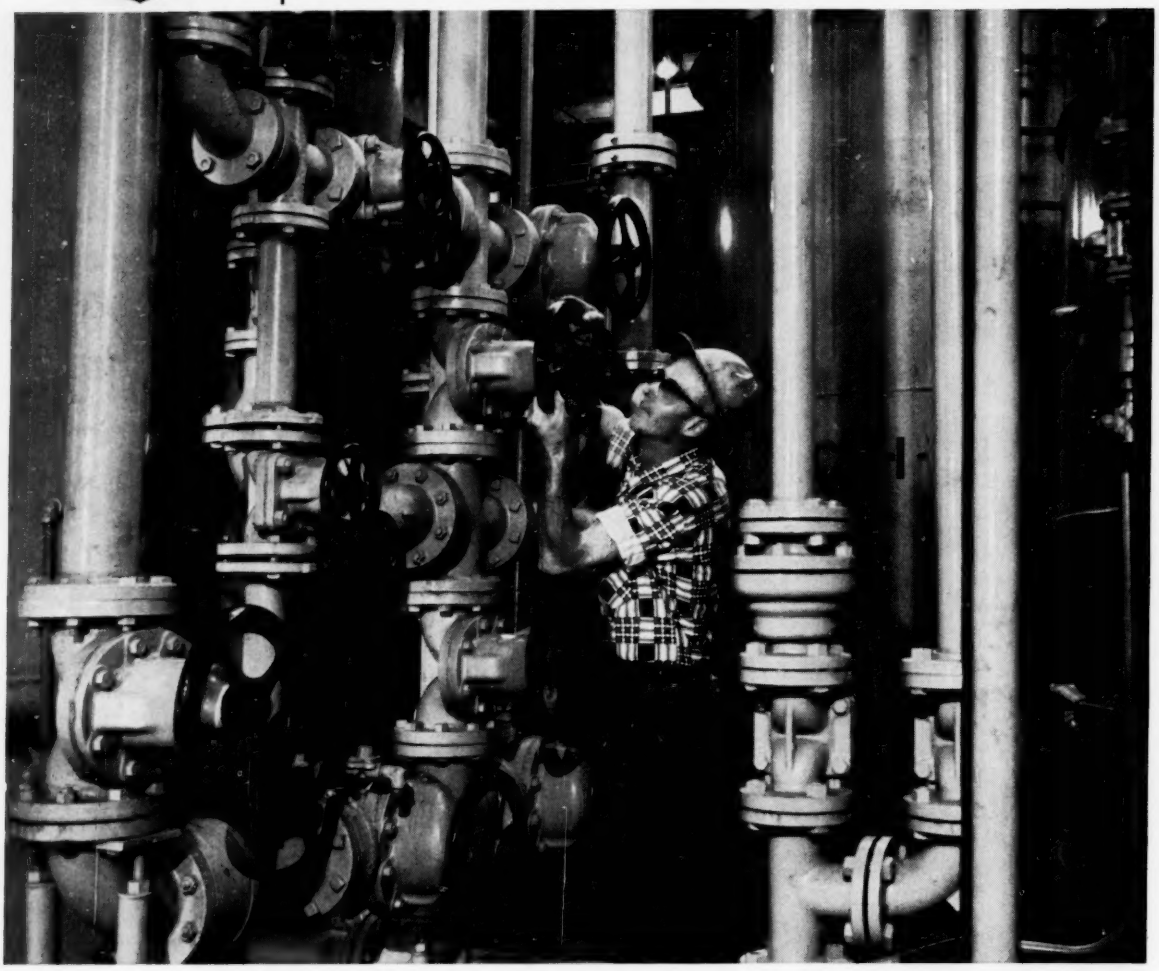


Published every-other-monday for Chemical Engineers in all functions

DOW | **SARAN LINED PIPE**



5 miles of pipe, 12 years of service

Saran Lined Pipe keeps process acids flowing!

When five miles of process piping must carry an unfailing flow of highly corrosive acids, thorium salt solutions and slurries . . . when frequent flow changes require quick, on-the-spot pipeline modifications . . . that's when the extreme corrosion resistance and easy workability of Saran Lined Pipe make this process pipeline a process lifeline.

Above is one section of the approximately five miles of Saran Lined Pipe which carries process chemicals in thorium recovery operations at the American Potash & Chemical Corporation's Lindsay Chemical Division plant, West Chicago, Illinois. In this process, Saran Lined Pipe is required to carry highly corrosive materials: sulphuric acid slurries for ore leaching; reacted thorium sulphate solutions and waste slurries; concentrated hydrochloric acid, hydrofluoric acid slurries. The pipe network has been in constant use since 1947, and *there's never been a major process shutdown because of pipeline failure!*

Equally as important to Lindsay as corrosion resistance are the workability and strength of Saran Lined Pipe. The nature of the process requires frequent flow changes, meaning frequent changes in piping. Necessary pipeline modifications are done quickly and easily by plant personnel, cutting process downtime to a matter of hours. And high physical strength of the pipe minimizes the need for extensive pipe supports!

Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200°F. They can be cut, fitted and modified easily in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Ave., Ferndale, Michigan, Dept. 2283AK10-5.

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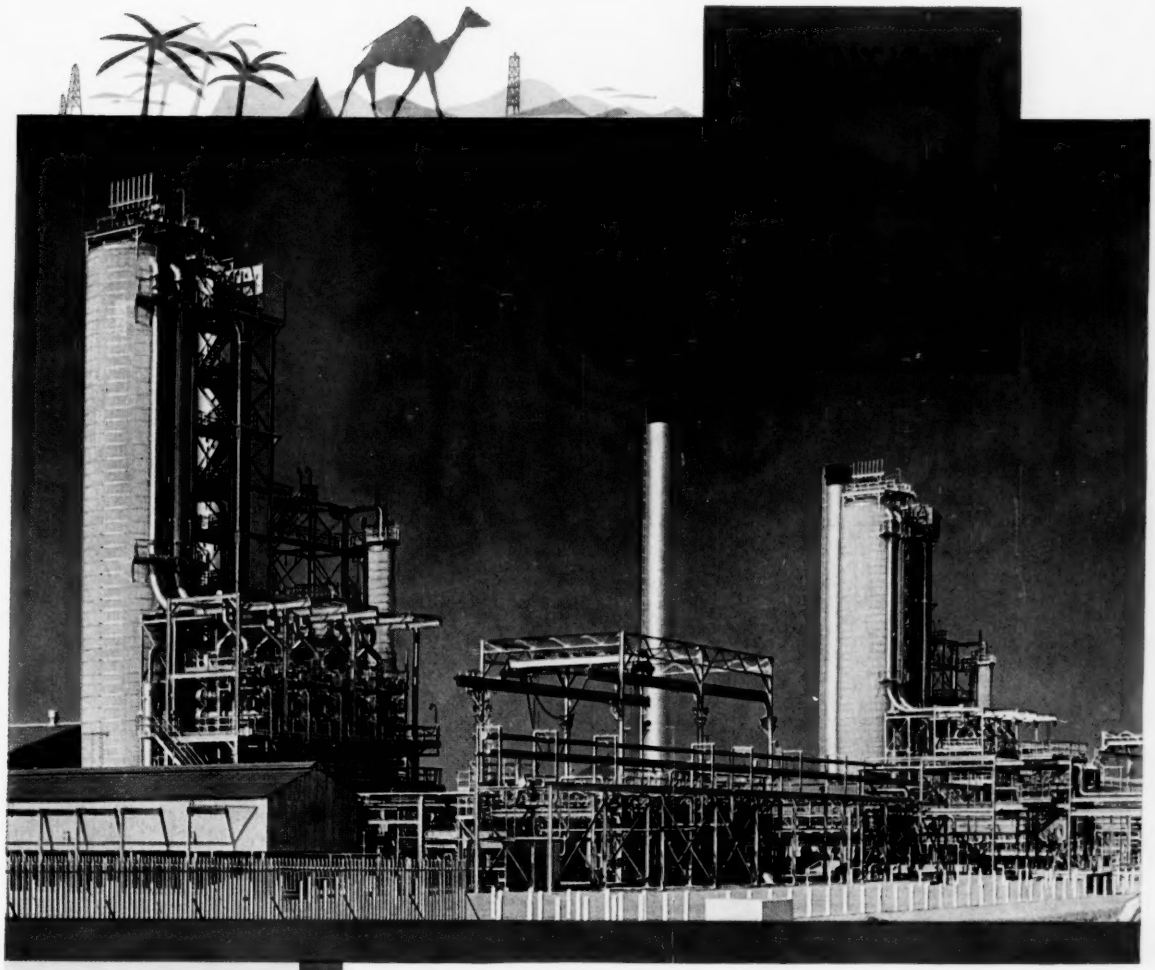

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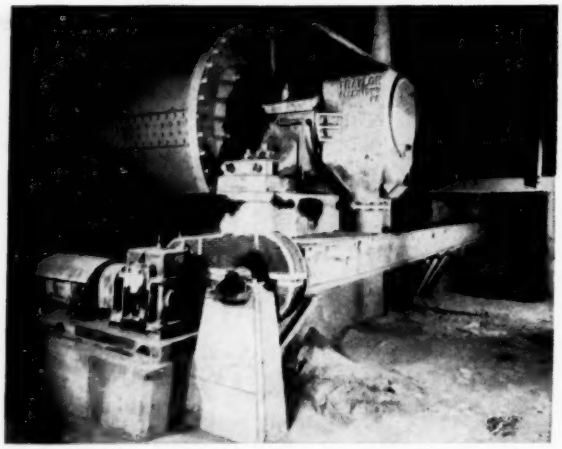
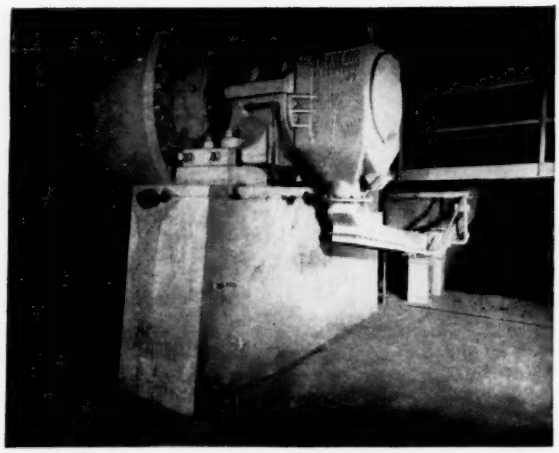


BEFORE: **Dirt, noise and mechanical breakdown** were constant problems in this cement plant, where two mechanical conveyors were used to collect raw materials. A 5 h.p. motor driving auxiliary equipment wasted valuable space and power, required frequent maintenance. Spillage clean-up wasted costly man-hours.



AFTER: **Clean, simple, quiet.** Notice the difference two 8" **F-H Airslide®** fluidizing conveyors have made. No dangerous **moving parts.** Nothing to lubricate. **Auxiliary equipment and foundations** are gone. Power needs are now only ⅛ of previous **needs. Fluidizing** saves wear and maintenance.

AIRSLIDE® Fluidizing Conveyor minimizes material loss . . . maintenance . . . moving parts

If you are now handling dry, pulverized materials, the F-H Airslide Fluidizing Conveyor can help you stop noise, and air-pollution, as well as speed flow and reduce maintenance cost.

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F-H Airslide conveyors fluidize dry, pulverized materials with low pressure air.

These materials literally flow at high speed, down the inclined conveyor. Power requirements are small.

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For unlimited applications, Airslide conveyors take up little space, and can be used singly and in combination with other Fuller pneumatic conveying systems. The movement of fluidized material can be around corners, between floors, through walls—nearly any conveying distance.

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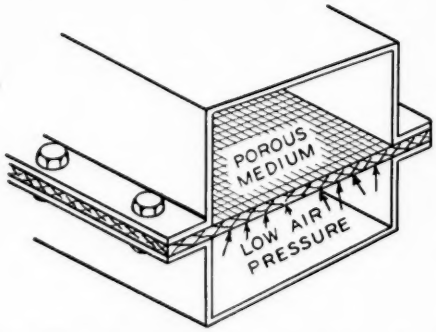
Can Fuller conveying systems help eliminate your housekeeping problems—cut your maintenance and handling costs? Write today, outlining your problem in handling dry, finely-divided materials. Fuller will gladly make appropriate recommendations.

"Pulverized Materials Flow Like Water!"



FLUIDIZING PRINCIPLE: Porous supporting medium divides conveyor section into two "compartments". Dry material flows down inclined conveyor, fluidized by low-pressure air entering beneath porous medium.

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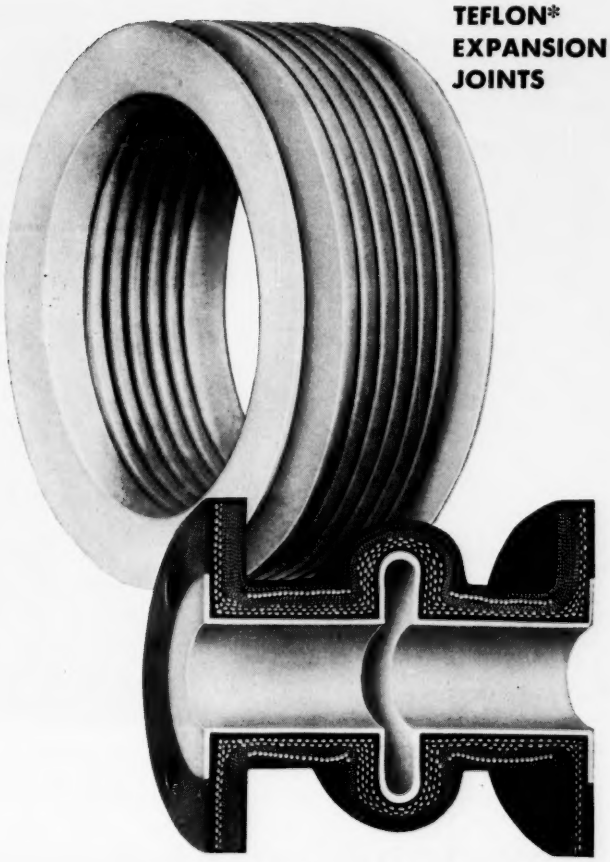
SOLID TEFLON* EXPANSION JOINTS



TEFLON-LINED EXPANSION JOINTS

Generally speaking, solid Teflon expansion joints are recommended for moderate service pressures. Where pressures rise as high as 125 psi., Teflon-lined expansion joints are recommended. Both will withstand temperatures above 175°F.

Garlock offers the most complete line of solid Teflon and Teflon-lined expansion joints. Exposed to the most reactive chemicals, these joints guard costly piping against pressure surges from pumps, compressors, and engines . . . reduce flange breakage, prevent stress, compensate for misalignment.

Discuss your application with your local Garlock representative. He can recommend from "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals. Call him, or write for Catalog AD-137.

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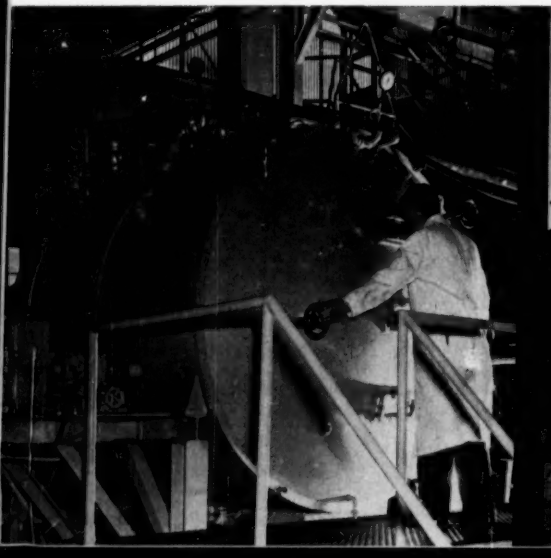
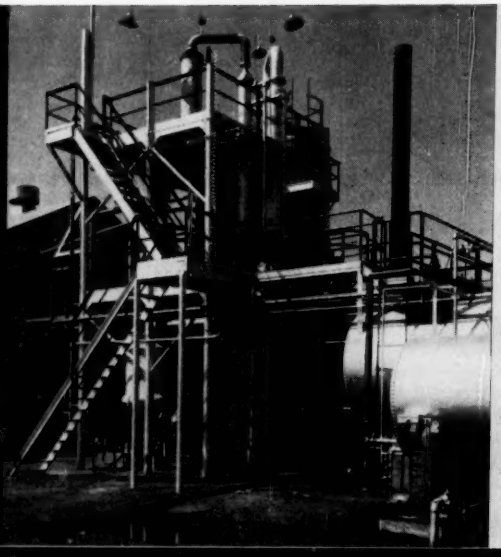
CHAS. PFIZER & CO., INC. uses a vacuum rotary dryer 30 ft. long and 5 ft. in diameter for Terramycin processing at their Groton, Conn., plant.

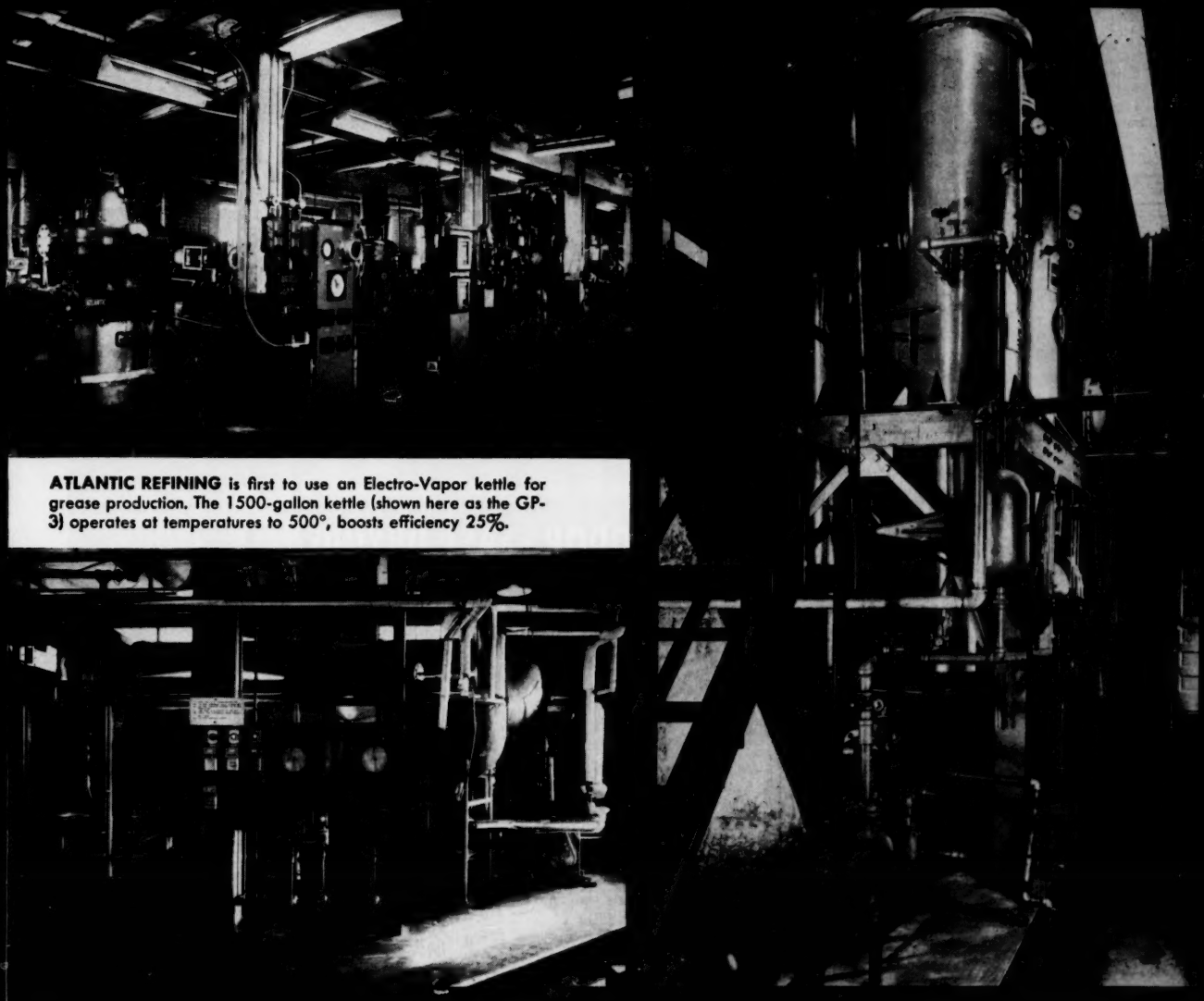
Buflovak processing equipment





Right:
BARECO WAX COMPANY, Division of Petrolite Corporation, uses two single effect, downflow evaporators at Barnsdall, Okla. Shown here: the 235 sq. ft. evaporator.

Left:
PILOT PLANT vacuum double drum dryer is part of modern equipment developed at the Buflovak customer service laboratory — a completely equipped product-process research center.



ATLANTIC REFINING is first to use an Electro-Vapor kettle for grease production. The 1500-gallon kettle (shown here as the GP-3) operates at temperatures to 500°, boosts efficiency 25%.

SEMET-SOLVAY produces powdered polyethylene with a spray cooler. Part of a new technique, this cooling equipment boosts production ten times with little increase in required floor space.

CHANNEL MASTER CORP. recovers cyanide at their Ellenville, N.Y., plant. A double effect, forward flow evaporator processes waste water from a zinc plating operation.

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Available by tank car, tank truck, barge and ocean tanker from the plant at Corpus Christi and from bulk terminals in Houston, Baton Rouge and Chicago.

TYPICAL ANALYSIS

Gravity, API	49.2
Specific Gravity 60°F/60°F	0.7831
Weight, Lbs./Gal.	6.520
Color, Saybolt	30+
Kauri Butanol Value	39
Sulfur	Free of H_2S,SO_2
Doctor	Negative
Copper Corrosion	Pass
Flash Point, TCC	104 °F
Aniline Point	128 °F
Distillation—IBP 312°F —FBP 349 °F	

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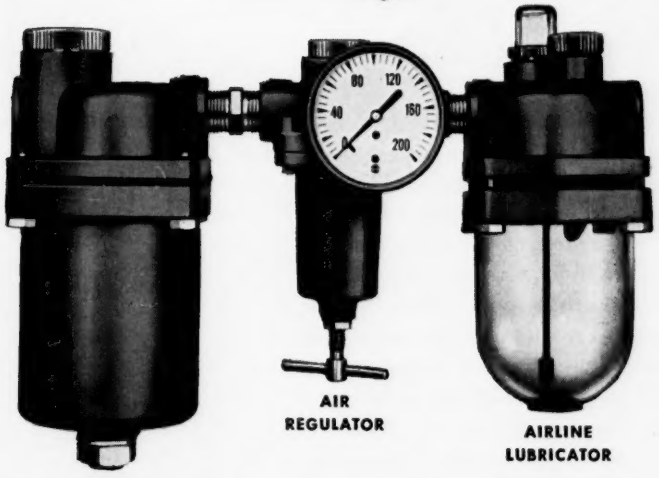
New Air Regulator with Gauge! Assures accurately controlled air—prevents erratic operation and damage to equipment. Design permits inlet pressures of 250 PSI—adjustments up to 125 PSI. Excess air pressure "bleeds off," within regulator, instantly.

Automatic Airline Lubricator. Compensating ball valve design controls air flow. Oil particles are atomized for most efficient transmission through supply lines. Result—uniform mixture regardless of air pressure and volume. Oil and air mixture proportionately constant. Reservoir may be filled at any time, assuring continuous operation. Nine-ounce capacity.



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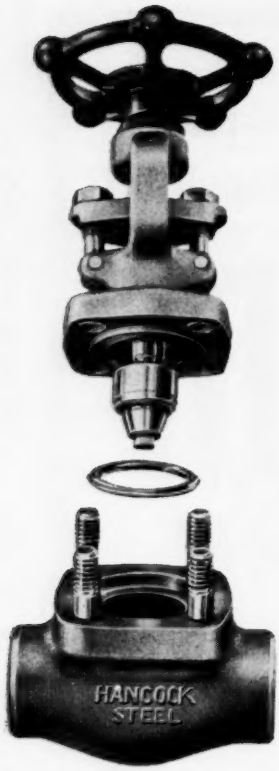
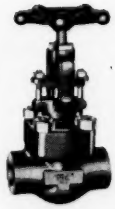


NEW VALVE-OLOGY

shuts off costly maintenance

Hancock 600# Steel Valves incorporate new concepts in valve-ology that reduce valve maintenance and equipment down-time. The forged steel bonnet and body have butting flanges so strong no distortion is possible. The flanges form a bonnet joint that utilizes the sealing power of a Flexitallic* gasket so effectively not even pressures exceeding ten times the rating of the valve can cause a blowout.

Hancock valve-ology makes full use of stainless steel to reduce your valving cost. Seat, disc, stem, swing bolts and nuts, thread bushing, packing gland follower—all are stainless steel. Globe, Angle, "Flocontrol", Lift Check, and Hi-Pressure Drop designs available. A high degree of standardization simplifies servicing and inventory needs. Your industrial supply distributor will gladly give you full details on Hancock Valve quality and performance. Phone him today.



Hancock 600# Steel Globe Valve. Type 5500 Line. Sizes: ¼" thru 2".

*Trademark of Flexitallic Gasket Company

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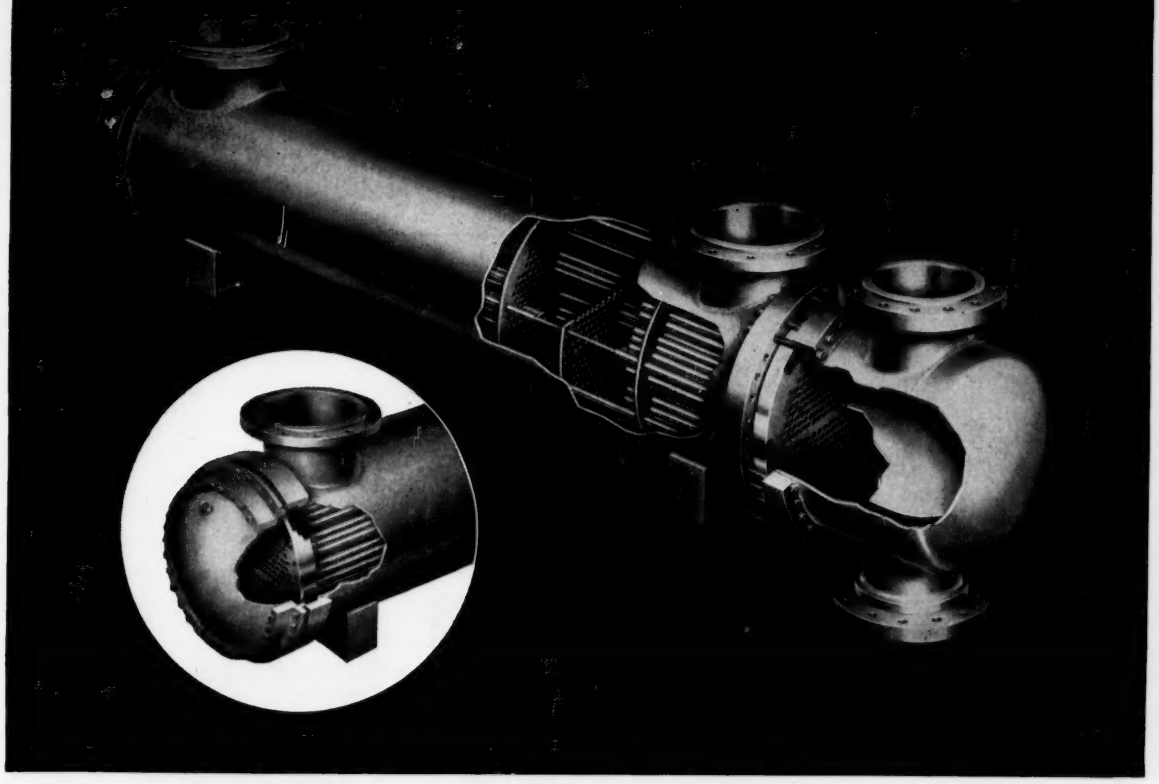

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Dirty Lines or Dirty Steam:

Lowest Initial Cost per pound capacity:

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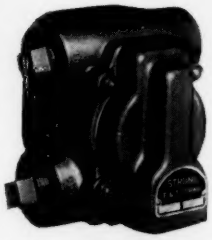
Eliminating Large Volumes of Air:

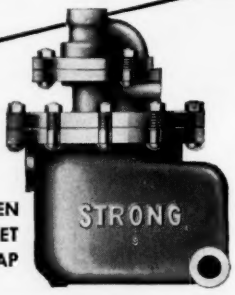
HYDRO-FLEX INVERTED BUCKET TRAP



FLOAT & THERMOSTATIC TRAP

Low Pressures with some air elimination:

Pulsating or Widely Varying Pressures:

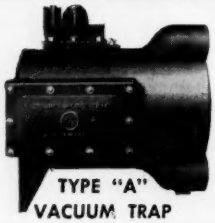


OPEN BUCKET TRAP

Continuous flow required:

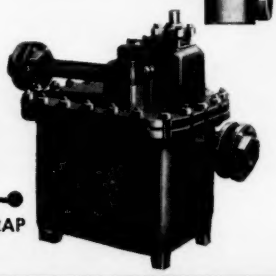
BALL FLOAT TRAP

Draining a line carrying a vacuum discharging to atmosphere:



TYPE "A" VACUUM TRAP

Draining a line carrying a vacuum or very low pressure discharging against a hydrostatic head or back pressure:



TYPE "M" VACUUM TRAP

on every type service

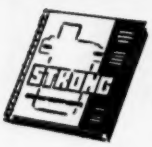
STRONG steam traps give you longer life, less maintenance

Strong offers six types of steam traps to answer every requirement for removing condensate from all types of systems.

You can specify these Strong Traps with the assurance that you will get maximum service life. Proof is the fact that replacement parts are still being ordered for traps sold 50 years ago!

Here are some low maintenance features built into Strong Traps. Screwed-in, replaceable valves and seats of wear-resistant ANUM-METL. Deep-drawn, one-piece stainless steel buckets. Extra-heavy body and cover construction. Thorough testing. Interchangeable parts.

You will be money and years ahead when you specify Strong Traps. For further information, contact your local Strong distributor — he carries complete stocks and replacement parts, offers prompt service.



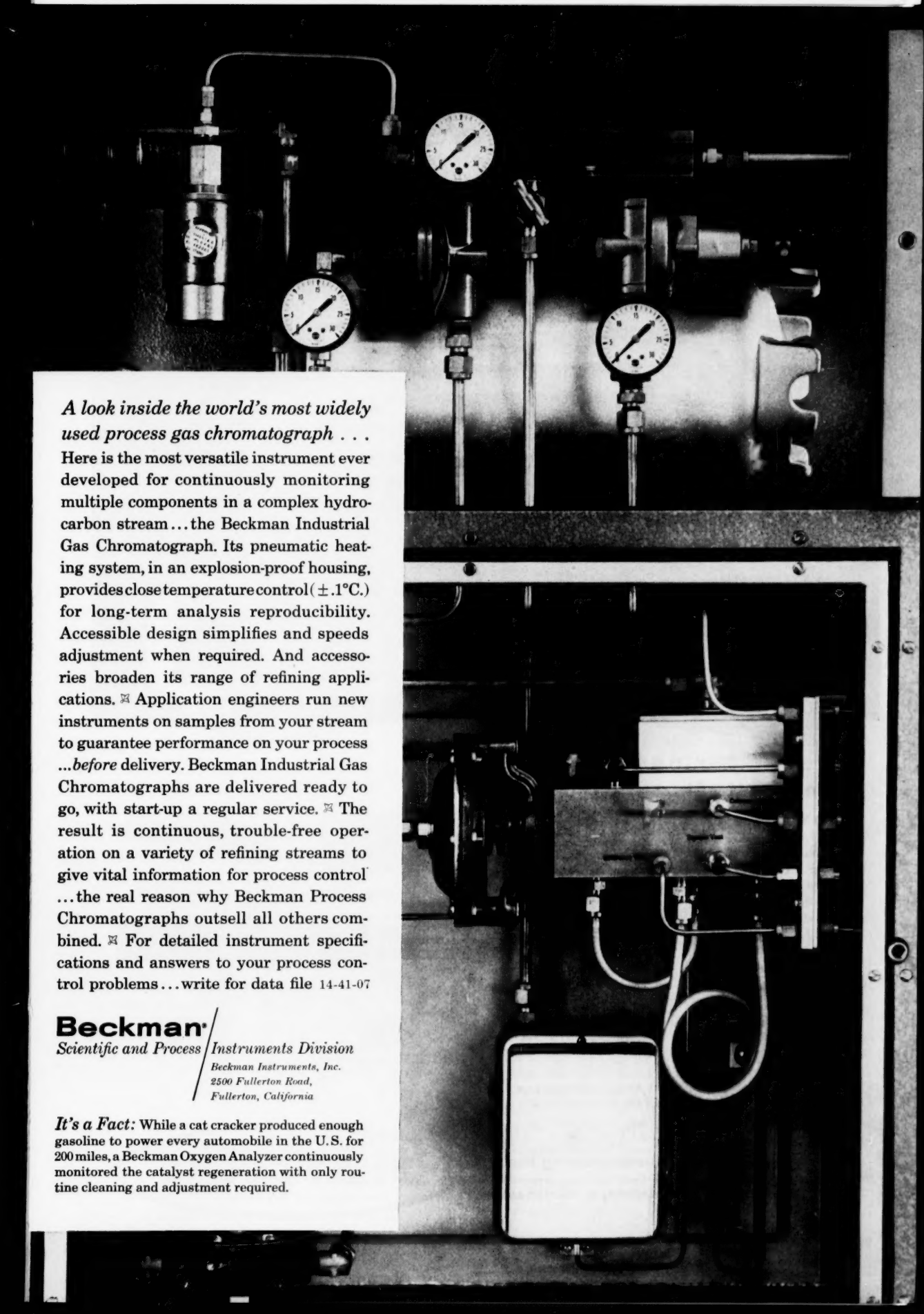
Selector Chart in Strong Catalog No. 69A gives trap recommendations for 45 types of equipment. Write for your copy or call your distributor.

4/S

STRONG, CARLISLE & HAMMOND

508 Sandusky Street • Conneaut, Ohio

steam traps • air traps • float traps • vacuum or pumping traps
F and T traps • continuous blowdown valves • separators • engine stops



A look inside the world's most widely used process gas chromatograph . . .
Here is the most versatile instrument ever developed for continuously monitoring multiple components in a complex hydrocarbon stream . . . the Beckman Industrial Gas Chromatograph. Its pneumatic heating system, in an explosion-proof housing, provides close temperature control (±.1°C.) for long-term analysis reproducibility. Accessible design simplifies and speeds adjustment when required. And accessories broaden its range of refining applications. ⌘ Application engineers run new instruments on samples from your stream to guarantee performance on your process ...*before* delivery. Beckman Industrial Gas Chromatographs are delivered ready to go, with start-up a regular service. ⌘ The result is continuous, trouble-free operation on a variety of refining streams to give vital information for process control . . . the real reason why Beckman Process Chromatographs outsell all others combined. ⌘ For detailed instrument specifications and answers to your process control problems . . . write for data file 14-41-07

Beckman
Scientific and Process Instruments Division
Beckman Instruments, Inc.
2500 Fullerton Road,
Fullerton, California

It's a Fact: While a cat cracker produced enough gasoline to power every automobile in the U.S. for 200 miles, a Beckman Oxygen Analyzer continuously monitored the catalyst regeneration with only routine cleaning and adjustment required.

NEW MULTI-ZONE PLATECOIL®

An exclusive* TRANTER advancement in heat transfer technology

*PATENTS APPLIED FOR

For new savings on more types of tank and process heating than ever before!

Now you can apply the time-proven cost and performance advantages of PLATECOIL over pipe coils to heating and cooling problems involving pressures up to 250 psi. DURAWELD construction, TRANSTEEL mild steel and MULTI-ZONE coil configuration are brand new design and construction features that provide for higher pressure containment and a margin of heat transfer capacity.

MULTI-ZONE coil configuration with multiple headers produces a reserve capacity for faster start-up and better temperature maintenance. High heat transfer efficiency saves tank space. Light weight makes installation easy and economical. Streamlined surfaces are easy to clean. Eliminate the cost of engineering, fabricating and installing pipe coils. Specify the new MULTI-ZONE PLATECOIL.

Standard PLATECOIL units

FACTORY-ASSEMBLED PLATECOIL banks.

In factory-fabricated styles to fit your needs

ROLLED to specified diameters

SINGLE EMBOSSED OR DOUBLE EMBOSSED

SEND FOR NEW PLATECOIL BULLETIN P61
for complete data and performance characteristics.

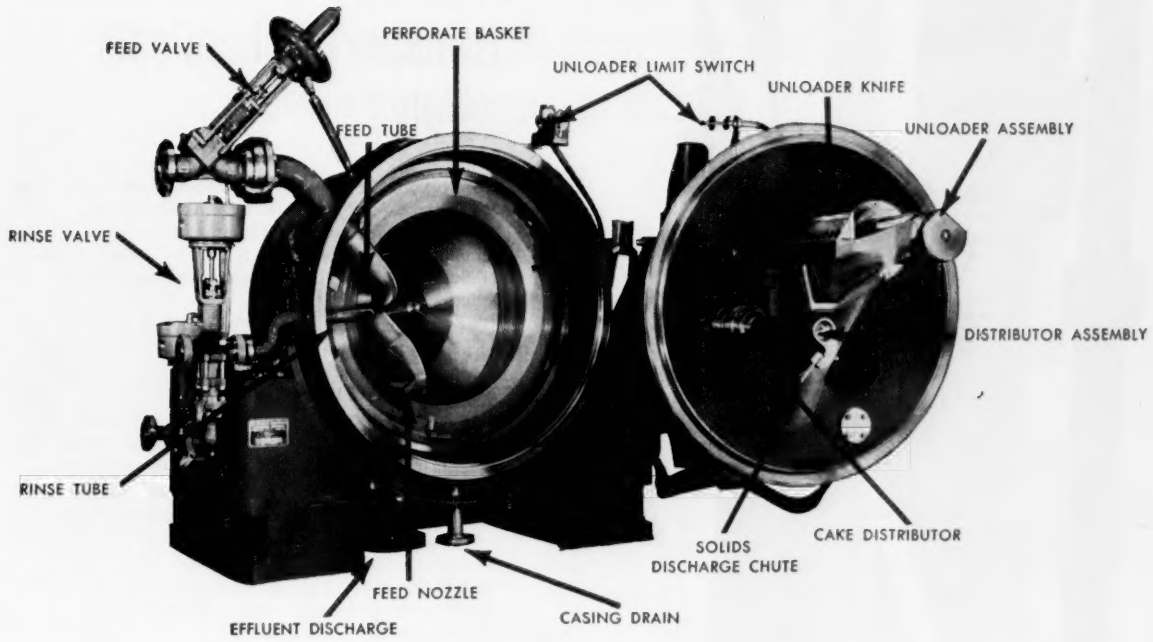
Tranter Manufacturing Inc.

LANSING 9, MICHIGAN

PLATECOIL® DIVISION

SHARPLES C-41 SUPER-D-HYDRATOR

The Advanced Design Centrifuge for High Capacity Deliquefication of Inorganic and Organic Solids



The C-41 is designed to load and unload the solids as quickly as process requirements permit; power requirements do not limit the capacity of this centrifuge.

To accomplish this end, a very special kind of ruggedness is built into the centrifuge—a quick acting ruggedness that makes it possible to load a crystal cake of 300 to 400 pounds at 1250 rpm in 6 to 12 seconds; and to unload the same 300-400 pound cake into the discharge chute in less than one and one half seconds!

Among other features, the C-41 offers flexibility of "chemical treatment" rinses so essential for extra high purity and dryness as required for example, by the polyolefins.

All the details in Bulletin 1286 just off the press.
Ask your local Sharples Office, or write direct.

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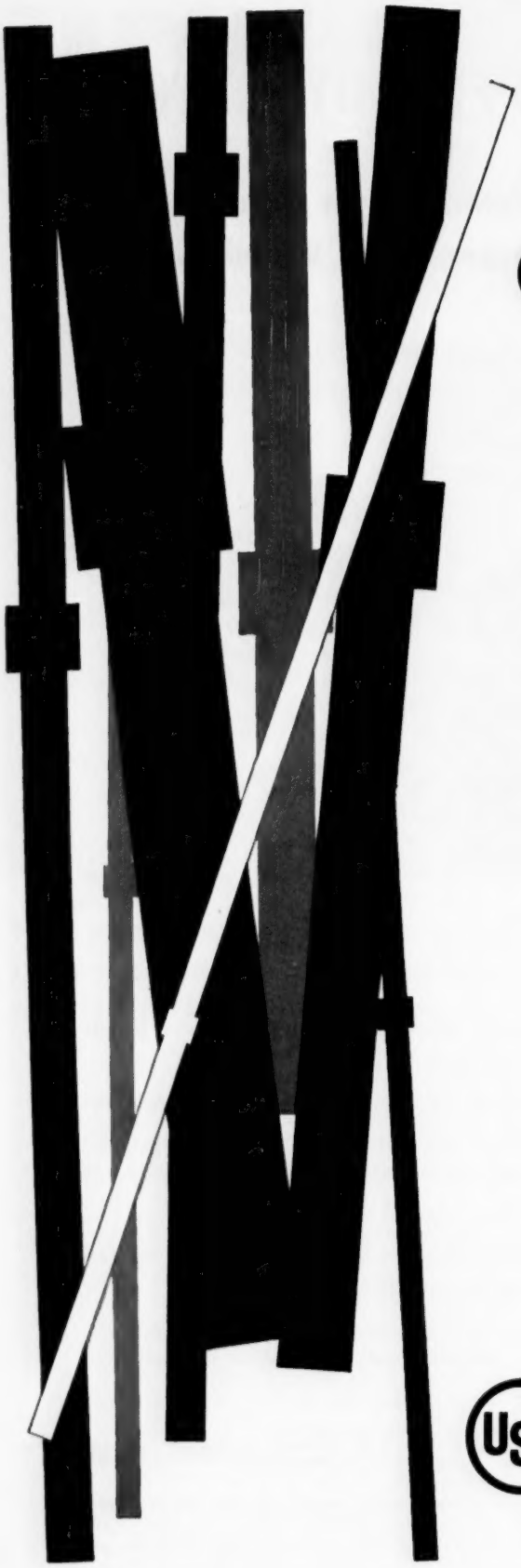


National PVC Pipe cuts maintenance costs, transports chemicals safely!

USS National Polyvinyl Chloride Pipe offers trouble-free performance, because it resists chemical attack, does not permit build up of internal deposits, installs easily and has a low initial cost. What's more, National PVC Pipe **does not contaminate** sensitive solutions.

USS National Polyvinyl Chloride Pipe has a variety of uses in the chemical industry, because it handles acids, alkalies, salt solutions and alcohols with the same impunity with which it transports water.

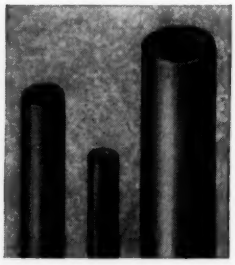
Two types of USS National PVC Pipe are available: Normal Impact—for installations requiring the highest chemical resistance attainable, together with high strength and excellent creep resistance.

High Impact—for installations requiring excellent chemical resistance and a high degree of toughness, even at low temperatures.

USS National PVC Pipe comes in sizes from ½ inch to 14 inches in diameter, and in Schedules A, 40, 80 and 120.

If you'd like more information, write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. **Ask for Bulletin No. 24.**

USS and National are registered trademarks



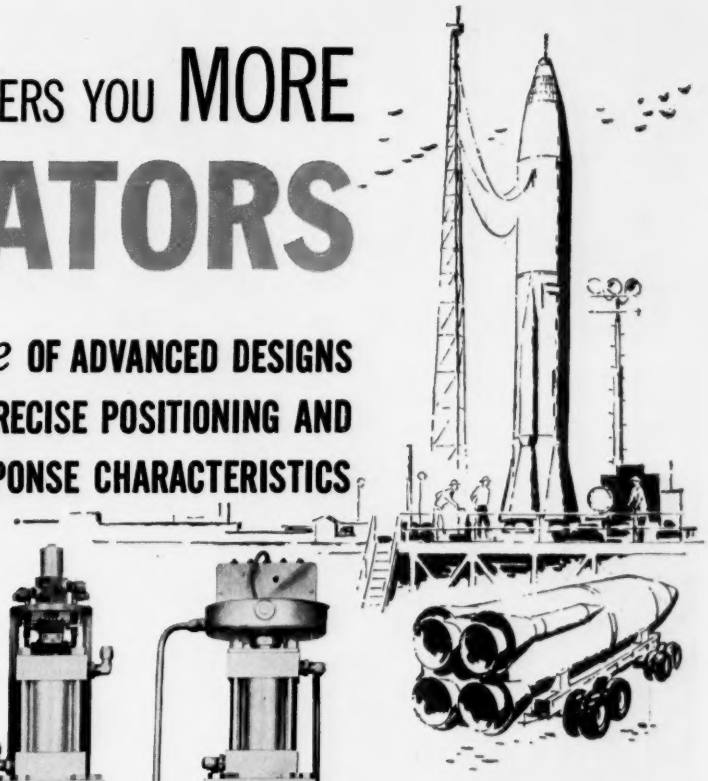
National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors

United States Steel Export Company, New York

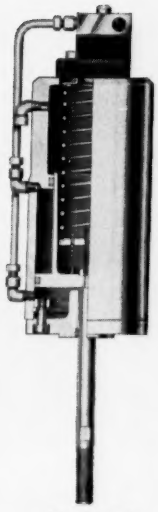
Annin OFFERS YOU MORE IN ACTUATORS

Your choice OF ADVANCED DESIGNS WITH MORE PRECISE POSITIONING AND DYNAMIC RESPONSE CHARACTERISTICS



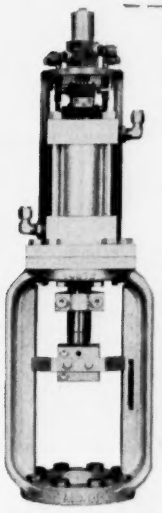
1542 & 1544 SERIES DOMOTOR POWERED ACTUATORS

Two types, "Direct Thrust" (illustrated) or "Lever" units are available for any application requiring accurate positioning in response to a pneumatic signal, such as butterfly valves, dampers, turbines and engine governors. Guaranteed positioning accuracy of better than 0.001" per inch of stroke over the complete range of piston travel is combined with a smooth operating action that provides an accurate, stable output force.



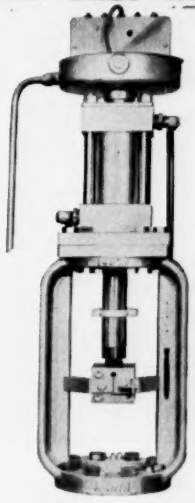
600 SERIES STROKE POSITIONING ACTUATORS

Offered primarily for the control of variable speed drives, rheostats, pumps and cams, as well as control valves, with strokes up to 6 inches and forces up to 2510 pounds of thrust. Compact and rugged, for easy mounting on existing equipment. May be operated from a standard 3-15 psi instrument signal, with a positional accuracy within 0.001" per inch of stroke.



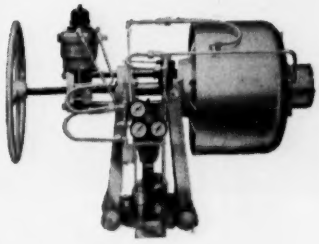
10,000 SERIES PNEUMATIC-HYDRAULIC ACTUATORS

For valves requiring strokes to 6 inches and thrusts to 100,000 lbs. Furnished on body assemblies where process conditions require very fine valve response, hi-speed and stability. Operate on 1500 psi oil supply system from any common instrument air signal.



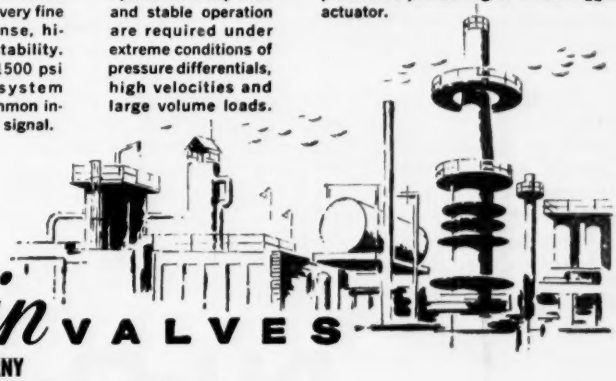
20,000 SERIES ELECTRO-HYDRAULIC ACTUATORS

Provide a means of converting an electrical signal to a powerful hydraulic positioning force, where high speed of response and stable operation are required under extreme conditions of pressure differentials, high velocities and large volume loads.



TOGGLE ACTUATORS

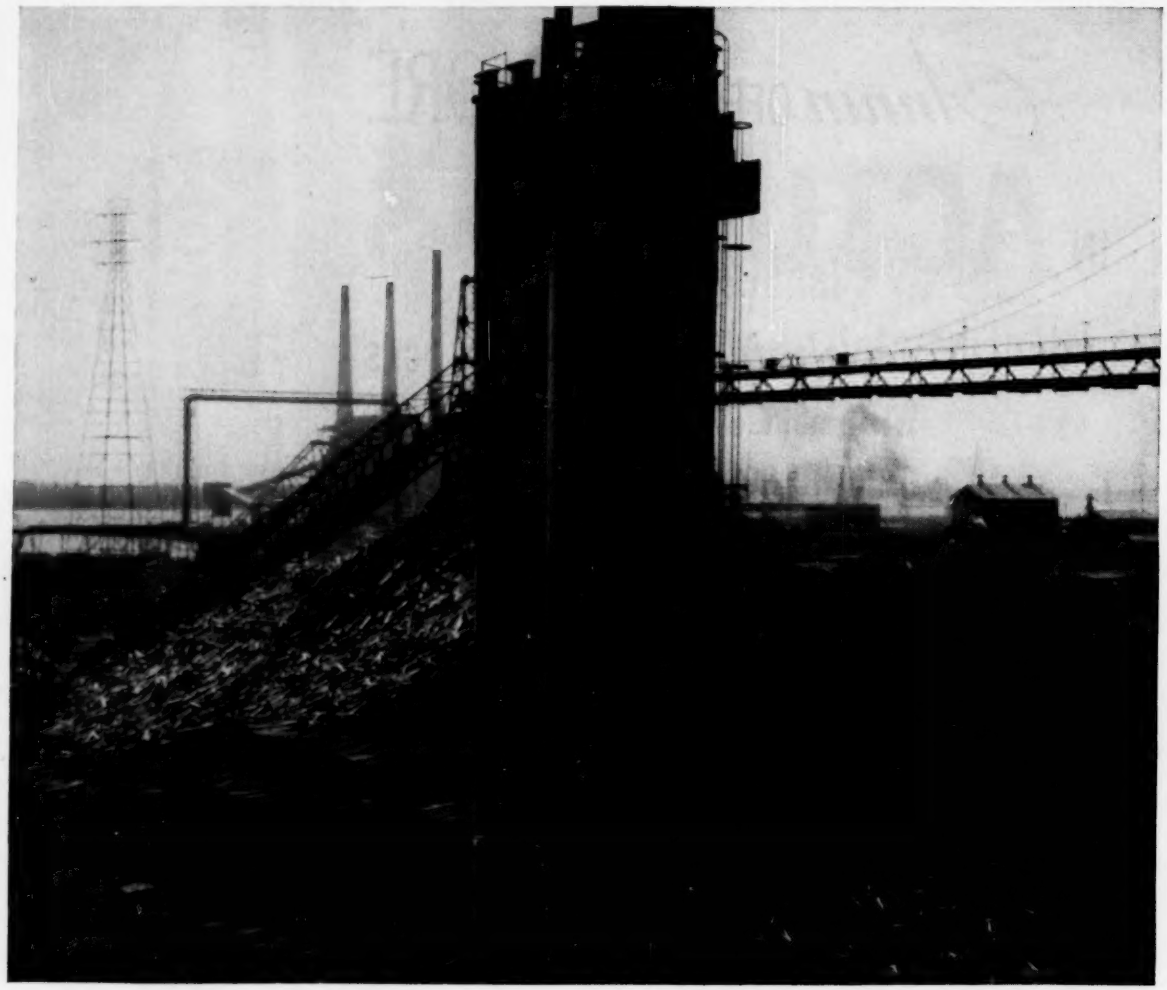
For process requirements where the unbalanced forces are extremely high, or where large through-puts are required. Three types are offered: pneumatic positioning, pneumatic on-off, and manual control, all embodying the toggle actuator; or a manual control arrangement can be combined with the pneumatic positioning or on-off toggle actuator.



Annin VALVES

THE ANNIN COMPANY
1040 S. Vail Avenue, Montebello, California

Write for Bulletin 1236-ST



Wet SO_2 line now in 4th year ...proves superiority of Ni-O-Nel alloy

. . . handles severely corrosive hot acids and oxidizing chemicals, too

That return gas line running down between the Jenssen acid towers shown above has been working there since 1955. It is at Scott Paper Company's Detroit plant.

The line is 16 inches in diameter and 77 feet long. Yet it was put up with no intermediate supports. It needed none, because of the extra strength and rigidity that Ni-O-Nel nickel-chromium-iron alloy provides.

This line carries wet SO_2 between the towers handling weak and strong acids. It's an outstanding replacement where a previous pipe failed. Periodic inspections reveal no leaks or need of maintenance.

Remarkable resistance to severe corrosives

Ni-O-Nel alloy has demonstrated in both laboratory and industry remarkable resistance to hot acids and oxidizing chemicals.

Chemical processors find it useful in handling hot sulfuric acid pickling baths, phosphoric acid up to 280° F, boiling organic acids such as acetic, phthalic and maleic, and nitric acid solutions at practically all temperatures and concentrations.

Ni-O-Nel alloy is also useful in salt water service. It resists pitting and chloride ion stress corrosion cracking.

For information on the engineering properties of Ni-O-Nel alloy and detailed data on its record of corrosion resistance, write for a free copy of "The Corrosion Resistance of Ni-O-Nel." *Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
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NI-O-NEL®

When You Order PITTSBURGH Industrial Chemicals

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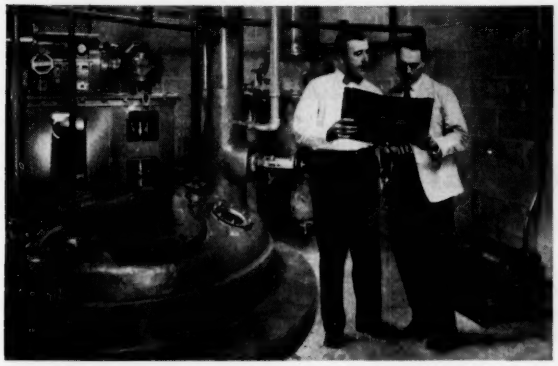
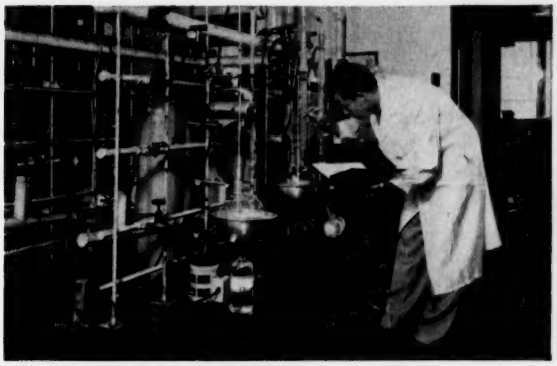
...a basic and integrated producer

...with pride in high product purity

...a respect for your delivery schedule





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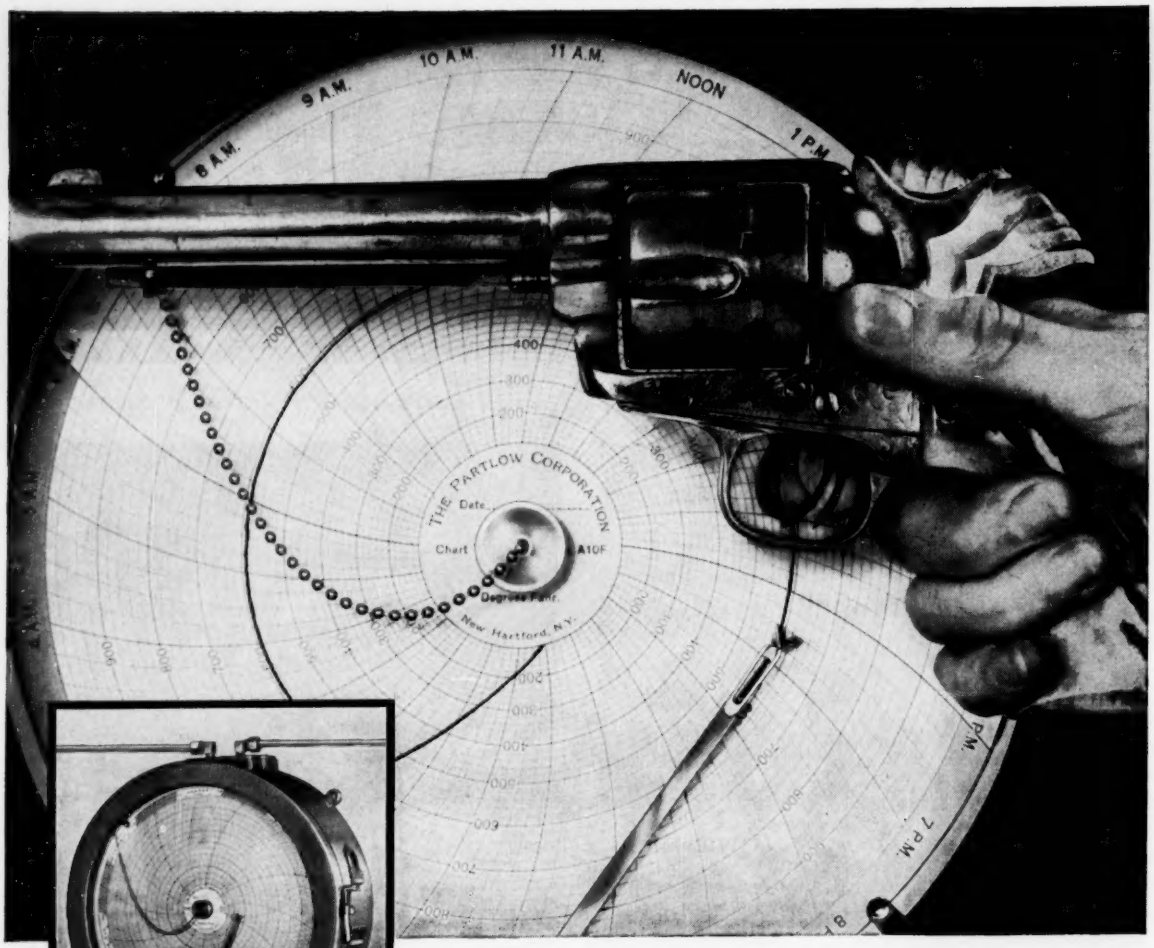
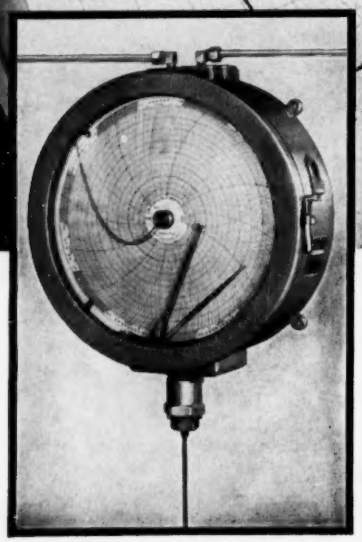




The Control Geared for

HAIR TRIGGER RESPONSE

even to Fractional Changes in Temperature!

NEW *Recording Pneumatic Temperature Control, Model RVA, available in any of 10 ranges from -30° to 1100° F.*

Extreme sensitivity—reflected in lightning-fast reaction to temperature changes—is a characteristic of *all* Partlow controls. Partlow Recording controls, however, *prove it in writing* . . . You can see for yourself how exceptional bulb sensitivity, teamed with advanced mechanical design, provide a minimum of "saw-toothing" on start-up, and maintain a rigid line of control when temperature reaches a predetermined set point.

Instant response, of course, is just one of Partlow's many built-in advantages. Another is rugged *design simplicity* that does away with hair springs and delicate electronic gadgets . . . that requires no electronic amplification . . . that permits fast, "screwdriver" replacement of the thermal element *right out in the field.*

If you use or manufacture process equipment within the -30° to 1100° F. range, there's a Partlow Pneumatic, electric or self contained gas control to fit your application *precisely*. Recording, indicating and non-indicating models available. For full details write The Partlow Corp., New Hartford, New York, Dept. E-109

Export: Ad. Auriema, Inc., 85 Broad St., New York 4, N. Y.

You can pay more but you can't buy better than

PARTLOW

TEMPERATURE CONTROLS

where trouble-free performance is a matter of national security

each of newest nuclear subs will take aboard **MORE THAN 4 MILES** of Scovill cupro-nickel, 30% heat exchanger tube

SCOVILL®

We're proud to be making this important contribution to the long-service dependability of these nuclear-powered submarines.

Like all other components of their nuclear-powered propulsion machinery and equipment, the Foster Wheeler main condensers, shown above being tubed with Scovill Cupro-Nickel, 30% Heat Exchanger Tube, have passed the most exhaustive performance tests it has been possible to devise. The same tube specification is also being installed in the ejector condensers. All of the tube is electronically tested on new equipment at the Scovill Tube Mills before delivery.

Scovill Cupro-Nickel, 30% Heat Exchanger Tube has a long record of trouble-free service on U. S. Naval vessels and those of many other nations. It is a first choice of design and operating engineers where salt water or corrosion conditions are severe, particularly at elevated temperatures and when the circulating media travel at high velocities. The corrosion resistance is excellent; strength of the alloy remains constant over a wide temperature range.

Why not discuss your own heat exchanger tube conditions and problems with Scovill Technical Service . . . considered by many the most experienced in the field.

HEAT EXCHANGER TUBE

for Applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel, 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube.

SCOVILL MANUFACTURING COMPANY, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY ★★★★★★★

18SC59

AO Flexible Mask Chemical Goggles Give All Five Major Advantages

1. LIGHT WEIGHT

2. OPTICAL FIDELITY

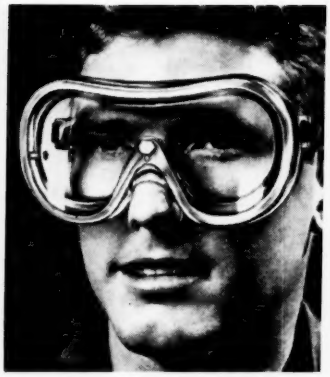
3. BETTER VENTILATION

4. WIDE ANGLE VISION

5. EXCELLENT FIT OVER PERSONAL AND SAFETY GLASSES

AO 711 SPLASH GOGGLE

Developed in conjunction with the same chemical company. Protects forehead, nose and part of the lower face (as well as the eye area) against molten sodium splash and radiant heat. Nose section features a plastic hook to which a fireproof drape attaches for protecting neck and chest. Plastic extension safeguards forehead. .050″ thick plastic lens. Same ventilating design as 710 goggle.



AO 710 SPLASH GOGGLE

Developed in conjunction with a leading chemical company. Particularly recommended where humidity is a problem. Provides assured protection against splashing liquids, spray, flying particles. Indirectly ventilated, yet has twice the fog resistance of similar goggles because of unique ventilating design. All parts replaceable. Clear or green lenses.

AO 484A GOGGLE

Louvers provide safe, ample, indirect ventilation, for comfort and fog reduction. Snug-fitting mask is an acid and alkali-resistant barrier to chemical splashes. Jumbo-size, one-piece, interchangeable acetate lens, slightly curved for wider vision. Clear frame, clear or green lens (for *green* frame, clear or green lens, order No. 485A).

YOUR NEAREST AO SAFETY PRODUCTS REPRESENTATIVE CAN SUPPLY YOU.

American Optical
COMPANY
SAFETY PRODUCTS DIVISION
SOUTHBRIDGE, MASSACHUSETTS
Safety Service Centers in Principal Cities

Always insist on AO Trademarked Lenses and Frames

RYKON *Grease*

passed this test at Corn Products Company

Situation: The springs in the grease chargers on expeller machines at Corn Products Company's Argo, Illinois, plant are under extra heavy tension. Due to this tension, oil formerly separated from the grease thickener in the grease cups. Bearings did not receive proper lubrication and the cups filled with grease thickener residue. The system needed cleaning every three months. Each time, large amounts of residue were found. Ten special-purpose greases were tried in an effort to solve the problem.

What was done: A Standard Oil lubrication specialist working with Corn Products' plant maintenance people recommended RYKON Grease #2 E.P. The system now needs cleaning only every six to nine months. Very little residue is found. Now RYKON Grease has become one of the important lubricating greases in use at Corn Products' Argo plant.

RYKON Grease is formulated with a unique non-soap organic thickener. The fibers of this thickener hold RYKON's fine quality base oil firmly in suspension. The grease resists water washing, high temperature and dirt contamination while providing superior lubrication to bearings of all types.

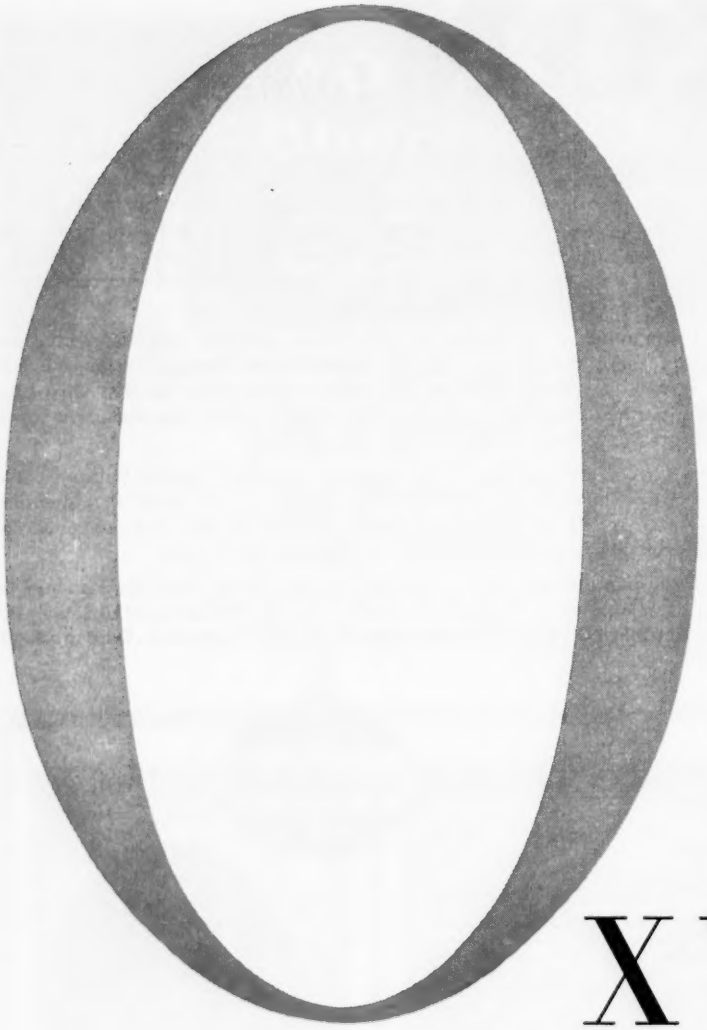
What you can do: Get more facts about RYKON Grease from the Standard Oil office nearest you anywhere in the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Ill.**

You expect more from **STANDARD** *and you get it!*

Standard's Arnold Parus and chief lubrication foreman Henry Anderson take a look at expeller unit's grease system. Arnold Parus is well equipped through experience and training to work with plant men on lubrication problems. Arnold has a B.S. degree from Bradley University and three years' field experience in this kind of work. He has also completed Standard's Sales Engineering School.

Quick facts about **RYKON** *Grease*

- Heat stable. At sustained high temperatures, RYKON Grease remains soft and grease-like.
- Resistant to water washing.
- Mechanically stable. Minimum change in consistency in service.
- Resistant to oxidation. Thickener acts as inhibitor.
- Exceptional rust preventive properties.



OXYGEN

FRIEND and FOE

Oxygen is one of the paradoxes of chemistry. Without it, life as we know it could not exist. Yet with products subject to oxidation it is a destroyer. Perhaps you have an oxidation problem. If so, you'll want to know more about Dalpac 4, Hercules di-tert-butyl-p-cresol—the leading antioxidant in many industries where hydrocarbon stability is a problem.

Hercules is a basic integrated producer of di-tert-butyl-p-cresol starting with its own raw material sources. That's still another reason why you can always depend on Hercules as a source of supply. We'll be glad to answer your specific inquiries and send technical information on Dalpac, its properties and possible uses.

DALPAC® 4

Oxychemicals Division • Naval Stores Department
HERCULES POWDER COMPANY
INCORPORATED
900 Market Street, Wilmington 99, Delaware

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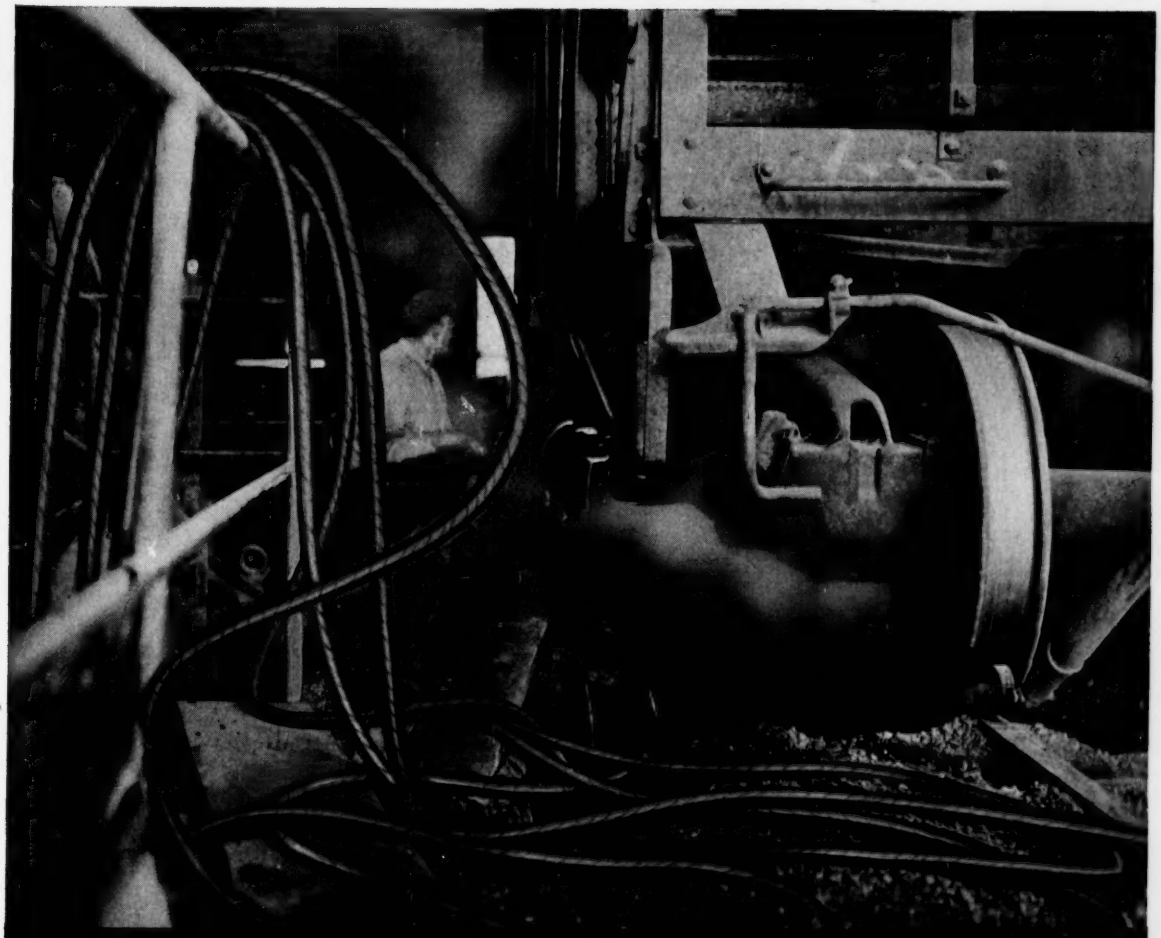

This plant turns on the steam to break loose frozen coal

The faster the coal flows the less it costs. This calls for steam at high pressure, and calls for a high pressure steam hose that's burst-protected, flexible, easy to handle. Management decided on Acme-Hamilton's wire braided steam hose because it meets all requirements and can be used for all steam applications safely and economically.

(A) Cover. Heat, abrasion, oil, sunlight and weather resistant.

(B) Carcass. 1 or 2 braids of high tensile wire. Prevents bursting, yet is very flexible.

(C) Tube. Handles saturated steam to 385° F. 200 lbs. working pressure. Won't loosen, soften or flake. Write Dept. M91.

Acme Hamilton

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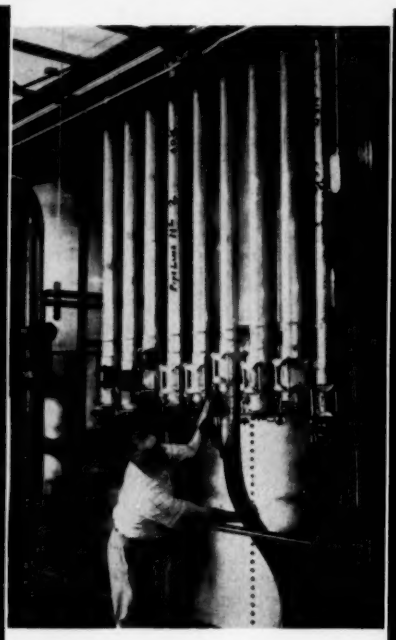
D. M. Nutter, Vice President in charge of production at Chippewa Plastics Company, Chippewa Falls, Wisconsin, reports:

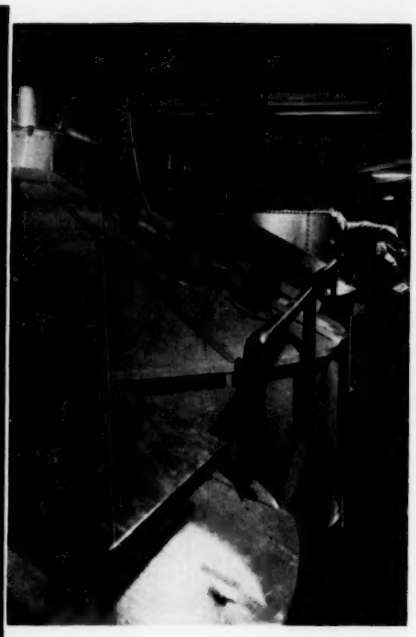
"Airstream conveying pays the rent on our new plant"

"Savings in labor and materials costs make this possible. Our Dracco Airstream Conveyor System replaces hand-loading methods used in our former plant. Now we move from raw materials to finished product . . . without manual handling. Here's how:"

"Bulk polyethylene for our film producing process is unloaded quickly, cleanly, smoothly. Once turned on, the system requires only part-time attention of one man."



"The suction-pressure system draws material to the Airstream Receiver, then blows it into any of 12 storage silo inlets. Conveying air is thoroughly filtered to prevent contamination. The quick-disconnect hose is easily switched from one inlet to another."

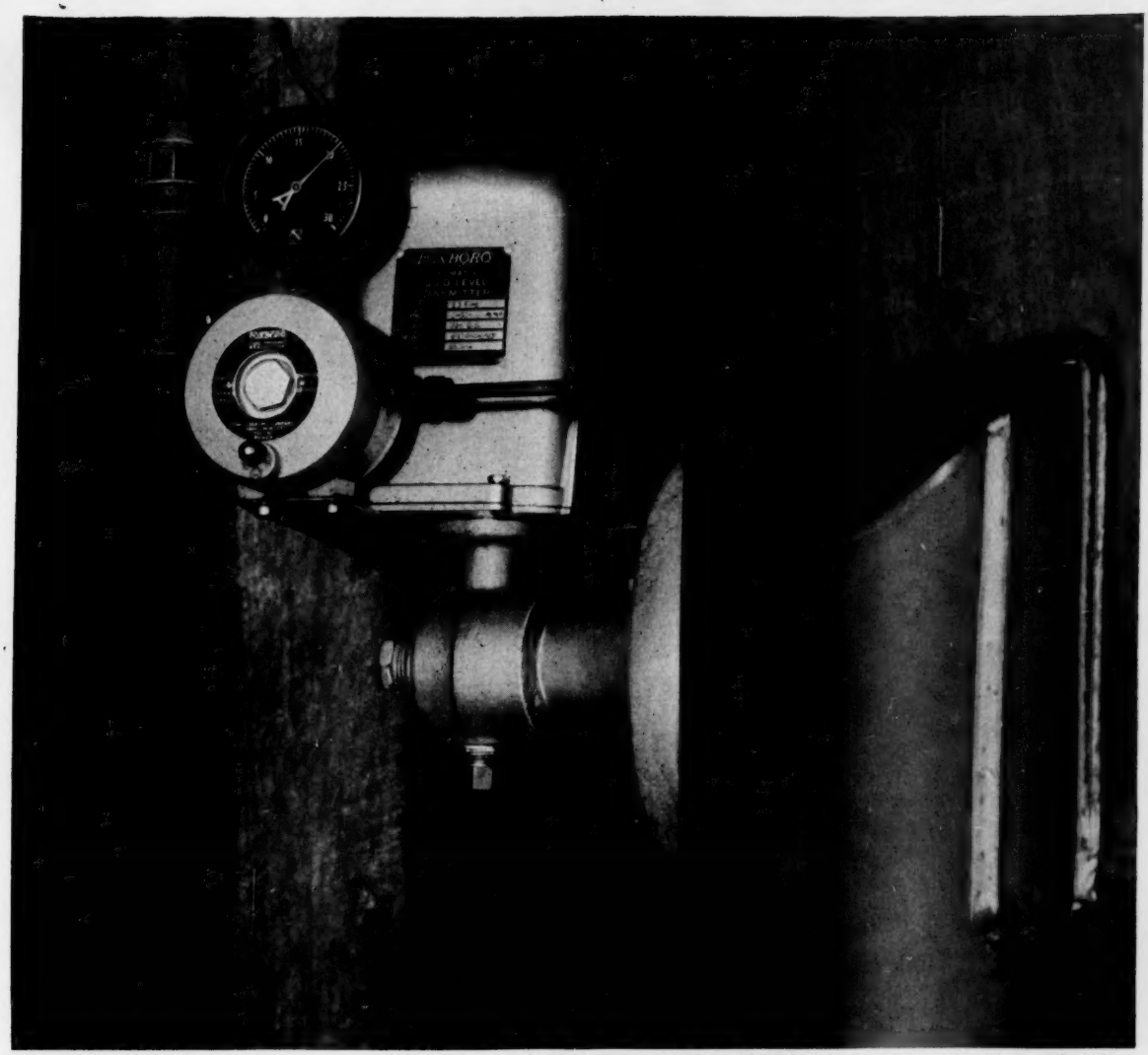


"Out-of-the-way conveying lines distribute different polyethylene resins to storage. The system handles a million pounds of material a month. It's been foolproof, maintenance-free, easy to operate. We believe it shows the way materials handling is going."

Growing industries, like plastics processing, are quick to pick up better ways of doing things. As you move ahead on progressive programs, consider air conveying for your bulk materials. Call on Dracco to help.

DRACCO DIVISION OF FULLER CO.
4040 East 116th Street • Cleveland 5, Ohio

DRACCO *airstream* conveyors
dust control equipment



Foxboro flange-mounted liquid level transmitter on 1st fine fiber wash tank at Union Starch and Refining Company's wet corn milling plant, Granite City, Illinois

UNION STARCH & REFINING REPORTS:

"Faster tank clean-up - less instrument maintenance with Foxboro Liquid Level Transmitters"

"We leave our Foxboro Liquid Level Transmitters right on our tanks at clean-up time," reports Robert Hays, Chemical Engineer at Union Starch & Refining Company, Granite City, Illinois. "The transmitter's flange-mounted, stainless steel diaphragm gets scrubbed right along with the vessel wall — without affecting its high accuracy of performance at all."

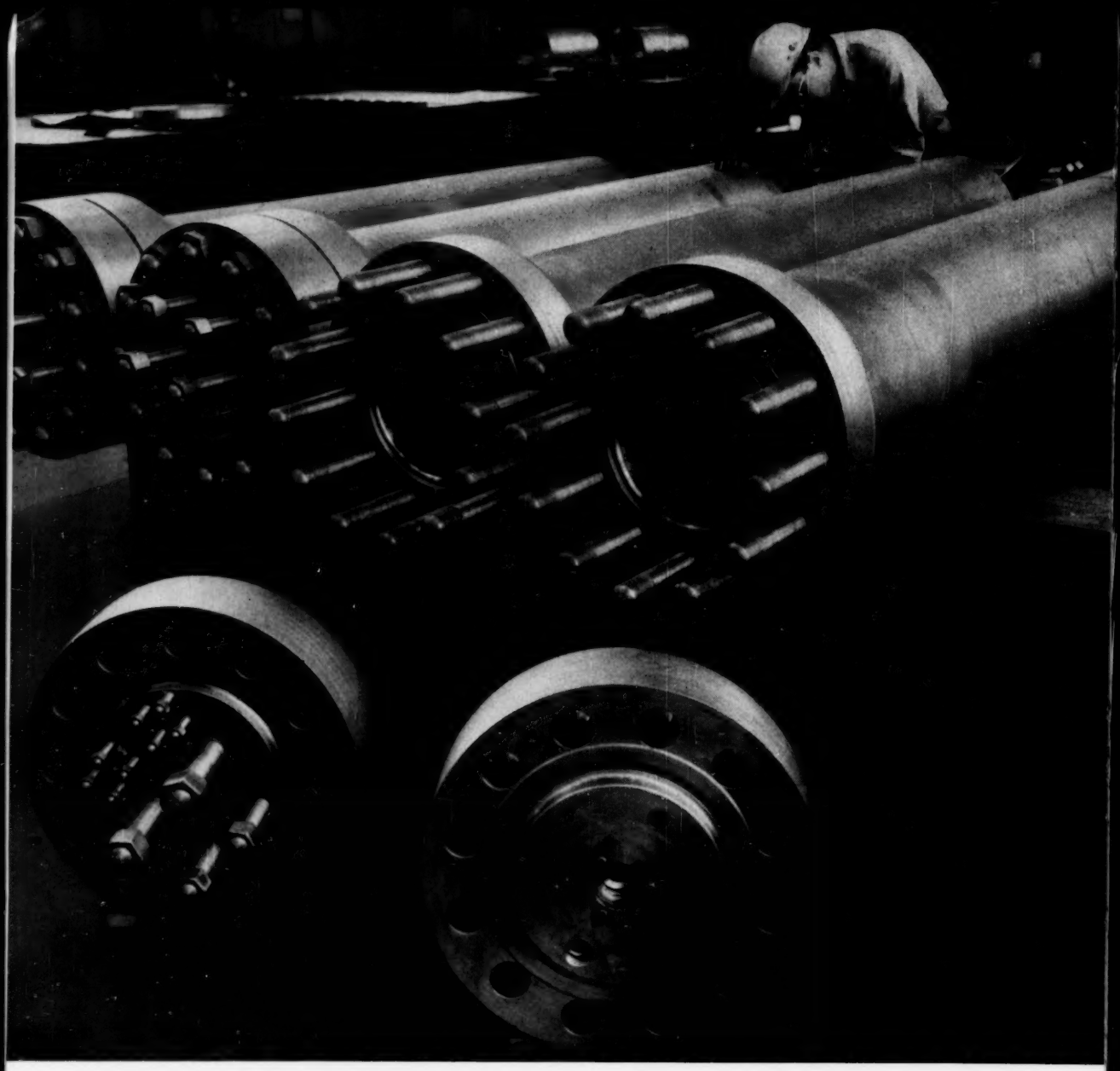
Foxboro Type 13 FA Level Transmitters have no floats or bubble-tubes — nothing to corrode or plug-up. 3-15 psi output signal operates standard recorders and controllers without the use of signal converters. And the 13 FA is available with elevated and suppressed ranges when process requirements make these features desirable.

For accurate, trouble-free level measurement and transmission, the Foxboro Type 13 FA Transmitter is your answer. Accurate to ± ½% on all types of liquids — from water, to highly viscous and corrosive liquids. Ranges from 0-20 to 0-850 inches water.

Ask your nearby Foxboro Field Engineer for full details, or write for Bulletin 458-52. **The Foxboro Company, 3610 Neponset Ave., Foxboro, Mass.**

FOXBORO

REG. U.S. PAT. OFF.



These separators will last for years

Almost ready for shipment to a chemical plant, these separators weigh about 2½ tons each. They measure 10 ft in length, and their inside diameter is 12 in. They will get a hydrostatic test of 9,000 psi before they are okayed for shipment.

Every Bethlehem forged vessel—whether it tips the scale at 150 tons or 900 lb—has the same rugged look about it. Even the most minor components are designed for long, heavy-duty service. That's why you can be sure they will last for years.

If you are planning new autoclaves, converters, separators, filters, reactors, or accumulators, we suggest you discuss matters with our engineers. They will gladly help plan the types and sizes of vessels that meet the requirements of your process.

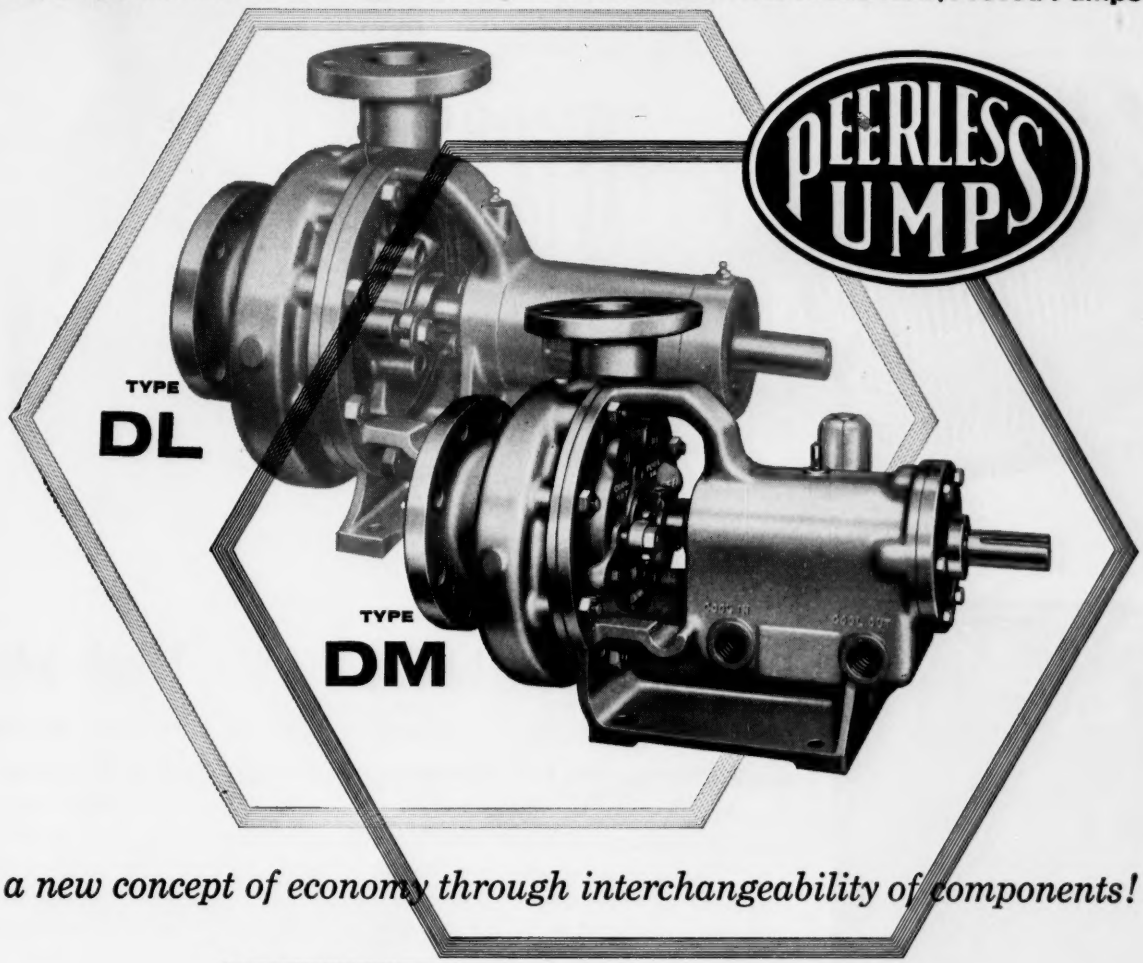
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Mr. Engineer: Cut Your Pump Inventory—Reduce Costs With These New, Proved Pumps



a new concept of economy through interchangeability of components!

PEERLESS PUMPS

INTEGRATED DESIGN

SUPERIOR DESIGN + TOP QUALITY CONSTRUCTION
+ MAXIMUM INTERCHANGEABILITY
+ OPTIMUM MATERIAL GROUPS AVAILABLE

= BROADEST HYDRAULIC COVERAGE
WITH MINIMUM CUSTOMER INVENTORY
OF PUMPS AND COMPONENTS

ACCESSIBILITY—Through ease of assembly and disassembly if and when required. **DURABILITY**—Through use of any machinable metal as materials of construction. **SERVICEABILITY**—Through designs that feature maximum ease of maintenance. **INTERCHANGEABILITY**—Through a choice of semi-open or enclosed impellers, oil or grease lubrication, air- or water-cooled back plates and bearing housings. **RELIABILITY**—Through the high performance standards set for these pumps, proving more than ever before, that Peerless Builds Dependable Pumps. **AVAILABILITY**—Shipment from stock of both complete pumps and pump components.

CAPACITIES: UP TO 1000 GPM • **WORKING PRESSURE**: UP TO 300 PSIG
HEAD RANGE: UP TO 430 FEET • **TEMPERATURE RANGE**: UP TO 450° F

Putting Ideas to Work

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Peerless Pump Division

Offices:
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Distributors in principal cities.
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PEERLESS PUMP DIVISION, FOOD MACHINERY AND CHEMICAL CORPORATION
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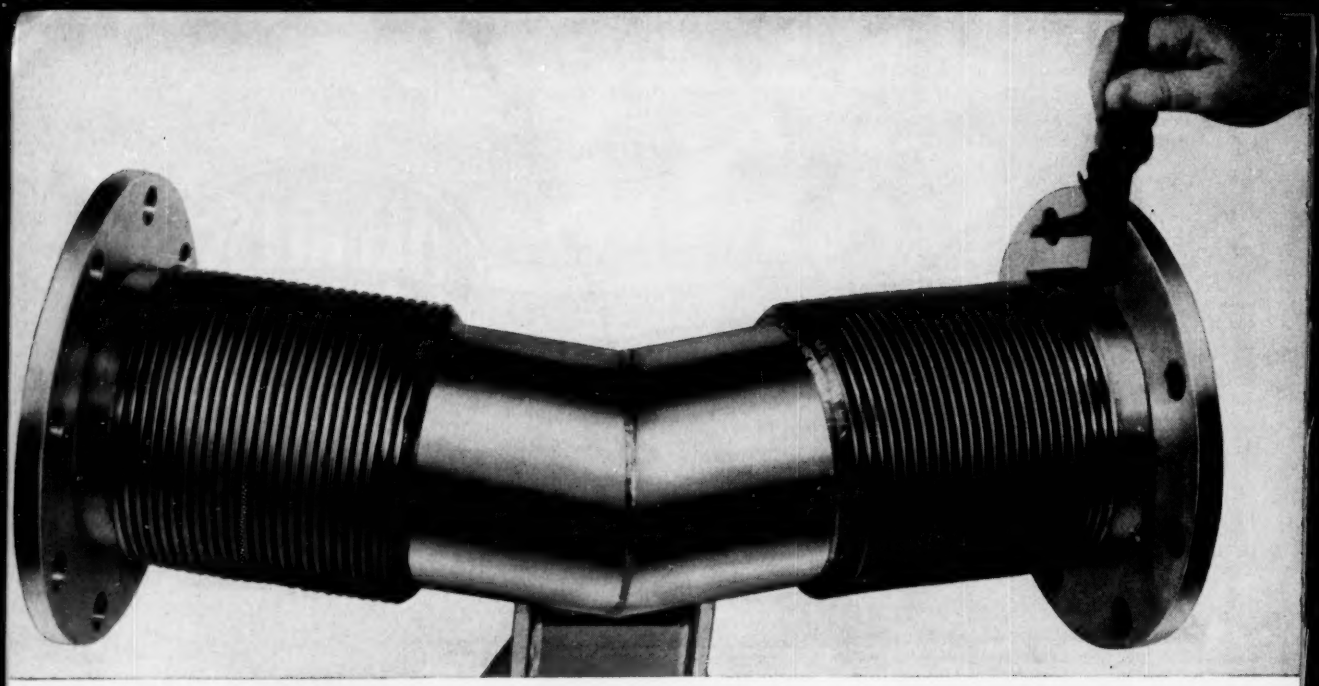
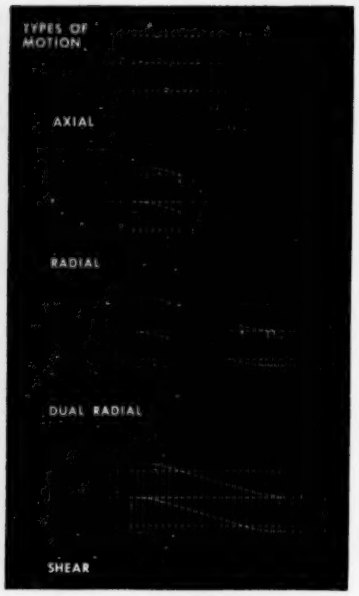
Visit us in Booth 831 during the Chemical Show, Coliseum: New York, Nov. 30 - Dec. 4, 1959



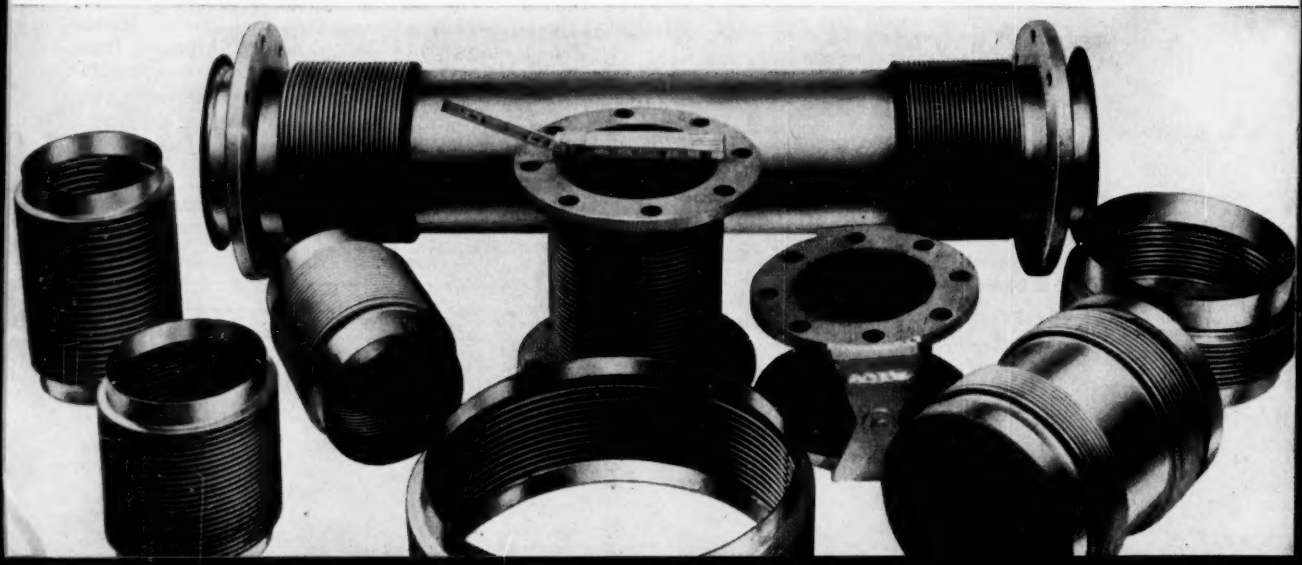


Expansion-joint tubing for big, tough jobs

New AX Tubing by Anaconda is available in Bronze, Stainless Steel, and other metals and alloys—from 4½" I.D. to 14" I.D.—to handle axial and lateral movement.

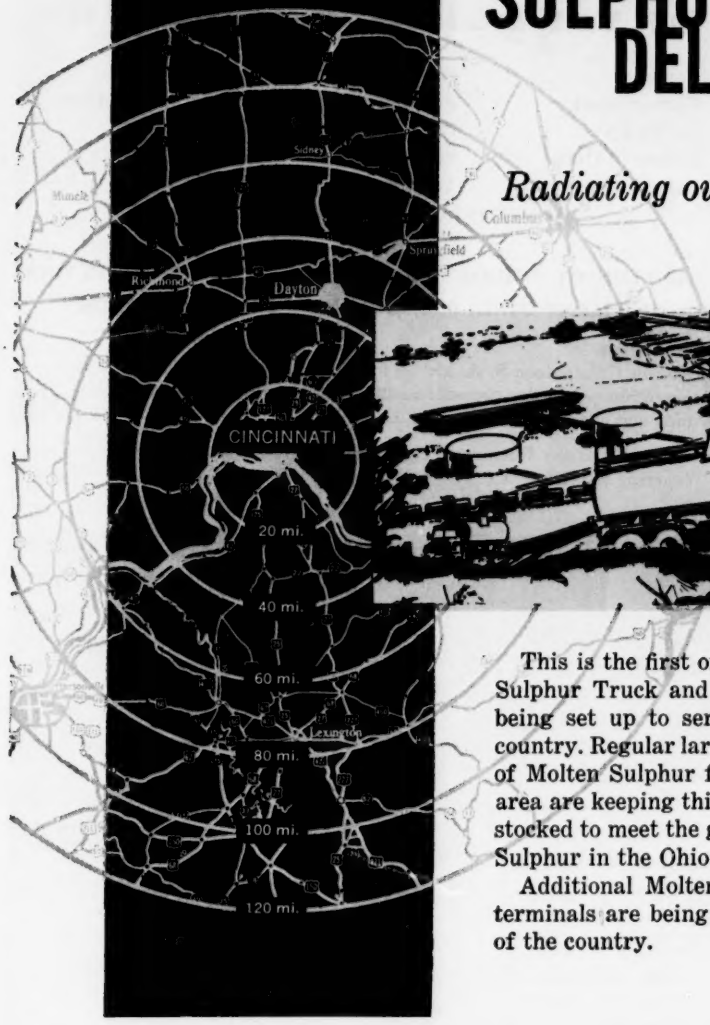
Need to compensate for contraction of piping suddenly cooled to minus 300°F by a large volume of liquefied gas? Want a bulkhead seal that "gives" with hull movement? Do you need a special assembly like that above, which handles an offset and a combination of lateral and axial movement? Wherever you need large diameter tubing to take care of movement shown in drawing at left, or simple offset, write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 59128

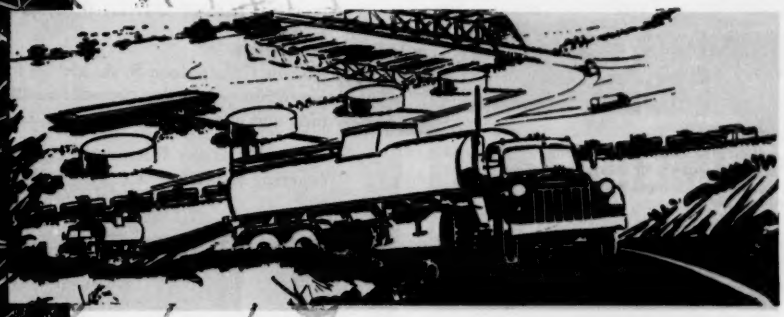
ANACONDA® METAL HOSE



NOW....PROMPT MOLTEN SULPHUR DELIVERIES

Radiating out from Cincinnati





This is the first of the TGS Terminal Molten Sulphur Truck and Rail Distribution Stations being set up to serve industrial areas of the country. Regular large tonnage barge shipments of Molten Sulphur from our mines in the Gulf area are keeping this Cincinnati Terminal well-stocked to meet the growing demand for Molten Sulphur in the Ohio River area.

Additional Molten as well as Solid Sulphur terminals are being considered for other parts of the country.

TEXAS GULF SULPHUR COMPANY
75 East 45th St., New York 17, N. Y. / 811 Rusk Ave., Houston 2, Texas

Sulphur Producing Units: Newgulf, Texas • Spindletop Dome, Texas • Moss Bluff, Texas • Fannett, Texas • Worland, Wyoming •

Molten Sulphur in tank *cars* can be delivered to any point in the States or Canada from our nearest mine or recovery plant. Barge deliveries of Molten Sulphur are available on all navigable inland waters. Solid Sulphur, as for many years, is deliverable all over the world. Large inventories at our mines assure industry it will get its supplies when needed.

VERSATILE SIMPLE AUTOMATIC

DRY SOLIDS CONVEYING

Cement	Petroleum Coke	Dolomite
Carbon Black	Pulverized Coal	Pharmaceuticals
Fertilizers	Fly Ash	Sand
Hydrated Lime	Fullers Earth	Fire Clay
Lump Lime	Soda Ash	Flour

Powdered and Granular Dry Chemicals

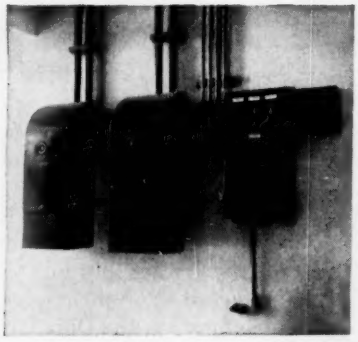
THE KENNEDY PNEUMATIC CONVEYING SYSTEM HANDLES THESE AND MANY OTHER PRODUCTS WITH *EASE* AND *ECONOMY*

Dry cement arrives at the plant by truck in KENNEDY Air Activated Containers. It is transferred directly by air pressure to this storage silo at 10 tons per hour through a 2½" pipe.

Eternit Colombiana S. A. looked for simplicity plus completely automatic operation for the dry cement handling system of their new asbestos-cement pipe and sheet plant at Bogota, Colombia.

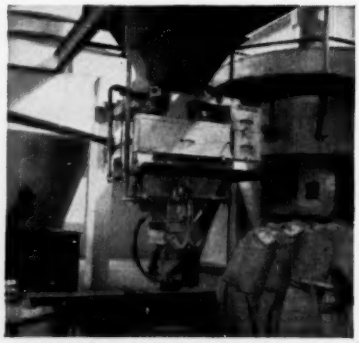
The KENNEDY Pneumatic Conveying System met—*and exceeded*—every exacting requirement.

A KENNEDY Pneumatic Pump is located immediately below the main silo. Batch transfer to intermediate bins is accomplished without screws or other rotating parts. Batch sequence is entirely automatic.



A low level control transmits a signal to this center as the level drops in any of three intermediate bins. All controls for the complete system are in the small right hand box; the two starters are for air compressors.

When actuated by the control center, this 3-way distribution valve opens the 2½" pipeline to the proper bin; the Pneumatic Pump then transfers a 1,000 pound batch of cement from the main silo.



Below each of the intermediate bins is a mixing station which correctly proportions the ingredients for the exact product composition desired. From delivery to finished mix—every operation is simply, automatically controlled.

This simplicity, versatility and dependability is characteristic of the KENNEDY Pneumatic Conveying System. Low maintenance is assured because there are no motors, screws or other major wearing parts exposed to the moving material.

Investigate this proven system for your materials handling problems.

KENNEDY VAN SAUN

MANUFACTURING & ENGINEERING CORPORATION

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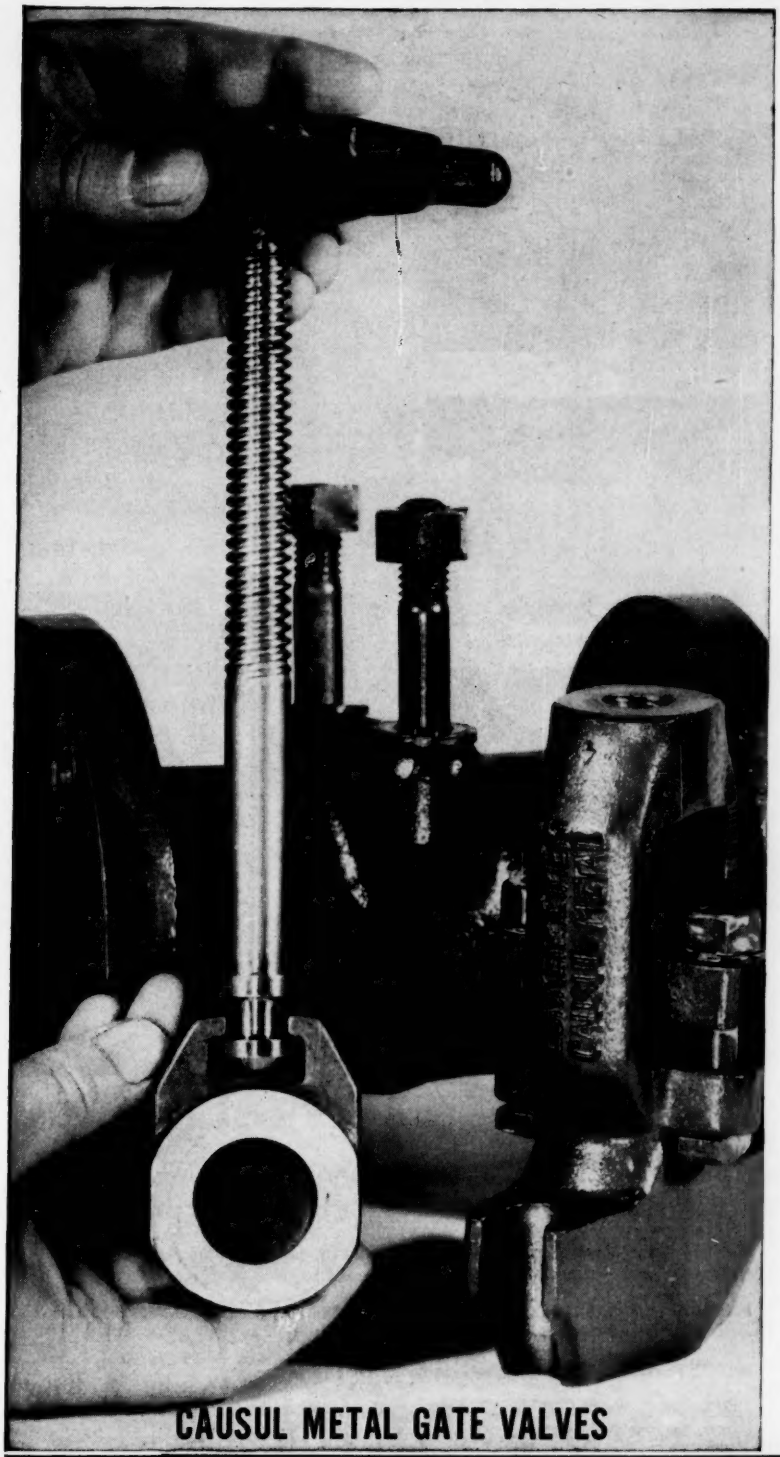
PRIMARY & SECONDARY GYRATORY CRUSHERS • JAW CRUSHERS • ROLL CRUSHERS • IMPACT BREAKERS • HAMMER MILLS • ROD AND BALL MILLS • KILNS • DRYERS • SCREENS • MECHANICAL & PNEUMATIC CONVEYORS • COMPLETE CRUSHING, LIME, CEMENT & CARBON PASTE PLANTS • KENNEDY RESEARCH AND TESTING SERVICE



"HIGH ALLOY" Performance at Iron Valve Costs

CAUSUL METAL GATE VALVES *by* LUNKENHEIMER

"Causul" Metal Valves offer *balanced* corrosion-resistance, yet cost far less than expensive high alloy valves. "Causul" Metal bodies and bonnets are teamed with Stainless Steel or Monel seats, discs, and stems to give maximum resistance to corrosion at the lowest possible cost. Heavy, thick body walls provide extra strength and durability. For full details on the maintenance-saving features of "Causul" Metal Valves, call the Lunkenheimer Distributor in your area. He will be glad to show you how you can keep valve maintenance cost down without investing in premium priced high alloy valves . . . Or write The Lunkenheimer Co., Cincinnati 14, Ohio.

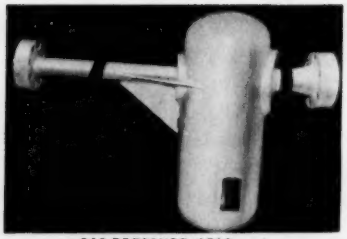
FREE Piping Practice Wall Chart on Valve Selection, Installation, Maintenance.

L-558-6

LUNKENHEIMER QUALITY

LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES



GAS PRESSURE, 1500 p.s.i.

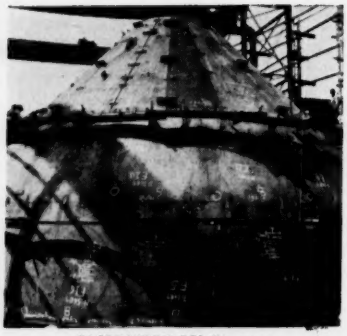
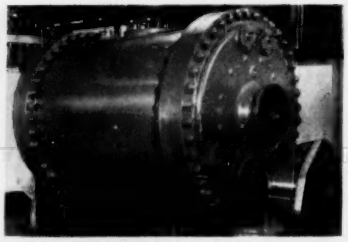


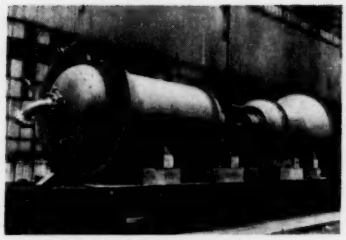
PLATE WORK, 55′ dia. cone

GALVANIZING POT

SPECIAL ALLOY STEEL DEFLECTORS

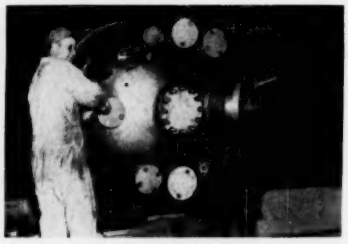


SPECIAL CHEMICAL VESSEL

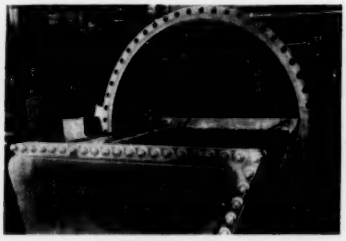


SPECIAL STAINLESS VESSELS

TOWER, 8′6″ dia. x 154′ in length

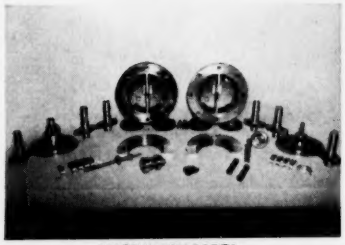


STAINLESS AUTOCLAVE



SPECIAL CONDENSER

WATER SHIPMENT



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MADE TO ORDER EQUIPMENT FOR OIL REFINING & CHEMICAL PLANTS

We place at your disposal one of the largest and most thoroughly equipped plants of its kind, featuring advanced production methods with experienced personnel in all departments.

PRODUCTS—Towers, Stills, Condensers—Kilns, Heat Exchangers, Pressure Vessels, Plate Work —All Codes, Any Material, Special Machinery, Machine Work.

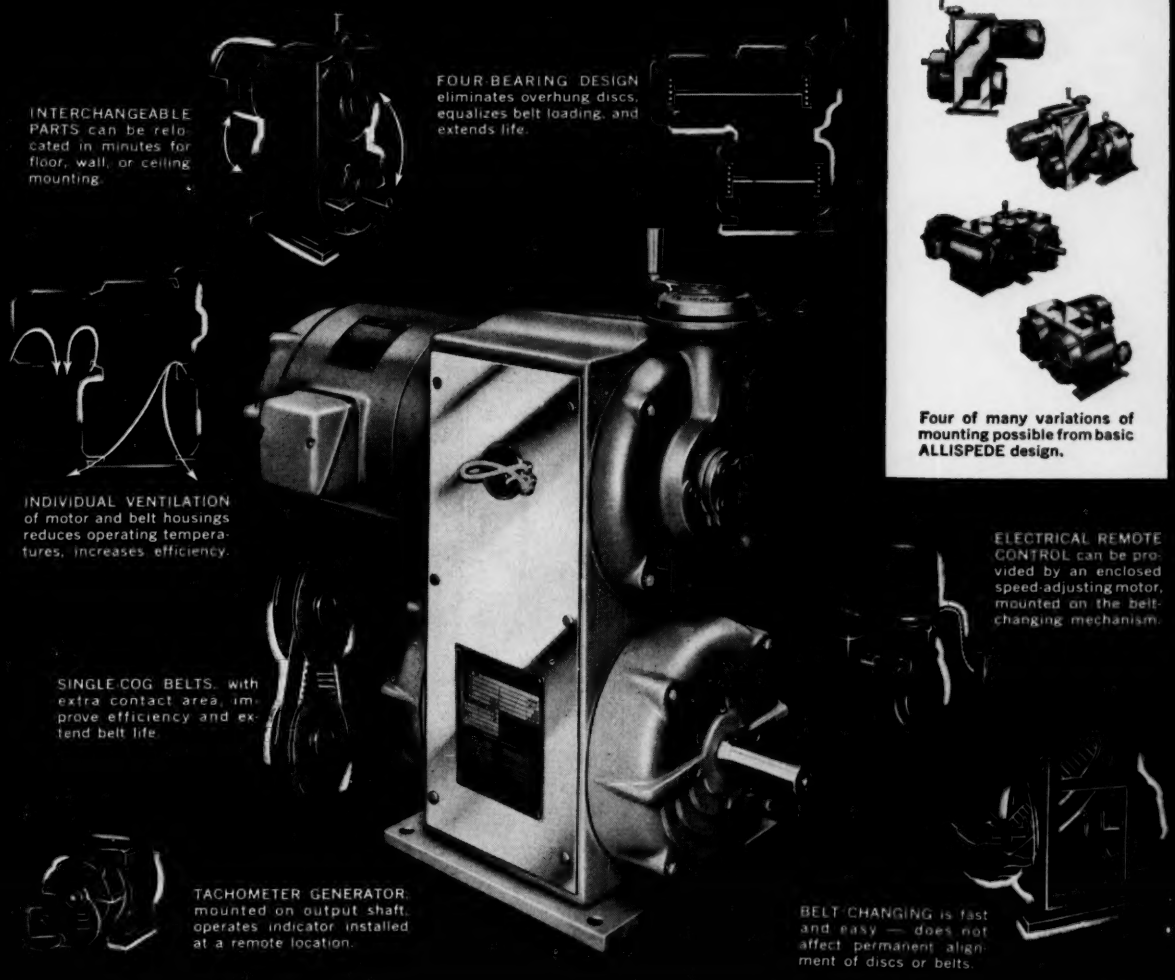
SPECIAL SERVICES—X-Ray Equipment—Stress Relieving Furnaces.

SHOPS—Boiler, Welding, Machine, Fabricating, Pipe, Blacksmith, Anglesmith, Sheet Metal, Copper, Separate Stainless Shop.

WATER AND RAIL SHIPMENTS—Our plant, including crane for loading and handling is located on the Delaware River with piers and deepwater to accommodate sea-going ships and railroad connections to all points.

SUN SHIPBUILDING & DRY DOCK COMPANY

CHESTER, PA.


INTERCHANGEABLE PARTS can be relocated in minutes for floor, wall, or ceiling mounting.
FOUR-BEARING DESIGN eliminates overhung discs, equalizes belt loading, and extends life.
INDIVIDUAL VENTILATION of motor and belt housings reduces operating temperatures, increases efficiency.
SINGLE-COG BELTS, with extra contact area, improve efficiency and extend belt life.
TACHOMETER GENERATOR, mounted on output shaft, operates indicator installed at a remote location.
ELECTRICAL REMOTE CONTROL can be provided by an enclosed speed-adjusting motor, mounted on the belt-changing mechanism.
BELT CHANGING is fast and easy — does not affect permanent alignment of discs or belts.

Four of many variations of mounting possible from basic ALLISPEDE design.

Let's look at the features of the ALLISPEDE* Drive

New Louis Allis drive offers accurate control—maximum belt life—long-run economy—low-cost versatility—ease of installation

Here's a drive so easily adaptable to changing physical and operating needs that it obsoletes obsolescence. You can relocate components — add or remove attachments and controls — in the field, in minutes.

Its *all-new* design improves performance and efficiency. Inspection, servicing, and belt-changing are a snap. Furthermore, maintenance is almost nil.

As for versatility — there's an Allispede to meet whatever mechanical drive requirement you have. Sizes up to 30 hp, output speeds from 1 to 10,000 rpm, and speed ranges up to 8:1. Motors can be open, drip-proof, enclosed, or explosion-proof—with ventilated or enclosed belt housings — for foot, P-base, C- or D-flange mounting on your machine.

Allispede is available with parallel shaft, or right-angle, integral speed reducers; special shaft extensions; integral magnetic brakes; electrical or mechanical remote control, and other modifications.

Interested? Contact your nearby Louis Allis District Office or write to The Louis Allis Co., East Stewart Street, Milwaukee 1, Wisconsin, for a copy of Bulletin 3600.

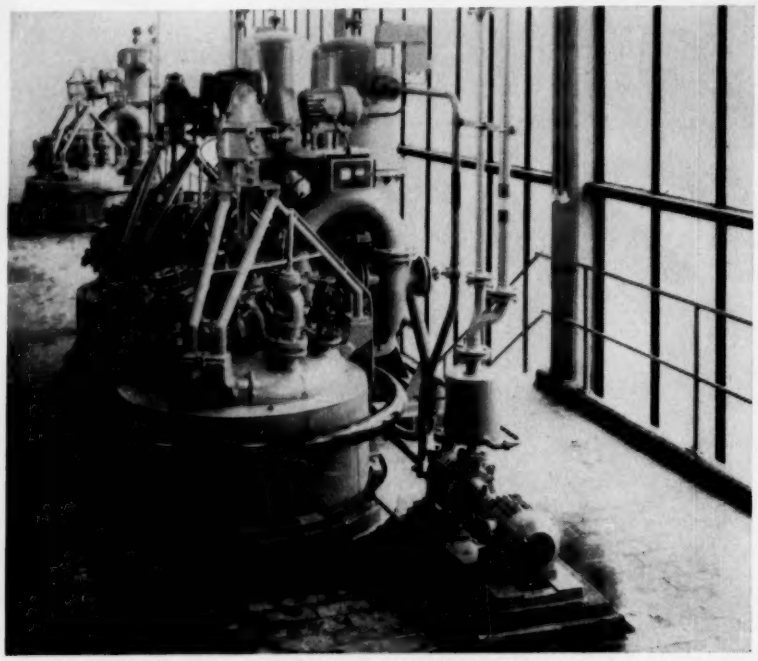
*Allispede is a trademark of The Louis Allis Company.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

ASD-133

FLUIDICS* AT WORK



These 12,000-liter Glasteel reactors produce chemicals of great purity at Riedel-de Haen plant in Seelze, Germany.

IN GERMANY

How Pfaudler Glasteel fights corrosion inside Europe's Common Market

Fine chemicals are booming in Germany, and Pfaudler equipment is there helping the boom.

Our German subsidiary, Pfaudler-Werke A.G. (established in 1907), fabricated the Glasteel reactors pictured above. They have the same Pfaudler quality construction developed in our American plants and are typical of the equipment we provide abroad. They completely resist corrosion from all acids, except hydrofluoric, and from most mild alkalies.

Riedel-de Haen in Seelze, Germany, produces some 500 fine chemicals and reagents in them. The units work continuously day and night to purity specifications that stretch out to five and six decimal places.

At another installation, one of Europe's biggest makers of pharmaceuticals also turned to the FLUIDICS program. Our German plant installed several Glasteel reactors of 4000-liter capacity. They are subjected to extremely severe acids and alkalies at pressures up to 75 psi.

If you have interests in overseas plants, we can offer you unusually valuable services on process equipment.

NEW FLUIDICS BUYER'S GUIDE. The many products and services offered by the FLUIDICS program are described in this bulletin. Write for your free copy to our Pfaudler Division, Dept. CE-109, Rochester 3, N. Y.

PFAUDLER PERMUTIT INC.
Specialists in FLUIDICS . . . the science of fluid processes

IN ALABAMA

Why Marathon Southern uses Glasteel in chlorine dioxide generation

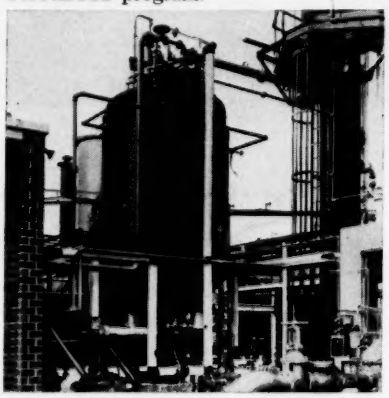
Pfaudler Glasteel solves the corrosion problems companies like Marathon Southern encounter in chlorine dioxide generation.

It completely resists sodium chlorate, sulfuric acid, methanol, sulfur dioxide—and any combination of these chemicals—as well as chlorine dioxide itself.

That's why you'll find Glasteel equipment so much in evidence at Marathon Southern's new chlorine dioxide plant in Naheola, Alabama. They collect their highly corrosive waste liquors in a 5000-gallon Glasteel Chemstor Tank. A 15,000-gallon Glasteel storage tank keeps their chlorine dioxide safe and pure until it's ready for use. The 5-ton-per-day primary generator is also of Glasteel.

Besides Marathon Southern, more than 30 other pulp mills are now using Glasteel equipment for everything from generators to storage tanks and towers, from pumps and pipes to fittings and valves.

If you're considering a new chlorine dioxide plant or expanding or revamping an old one, take advantage of Glasteel, the modern material of construction for ClO_2 equipment, provided by our FLUIDICS program.

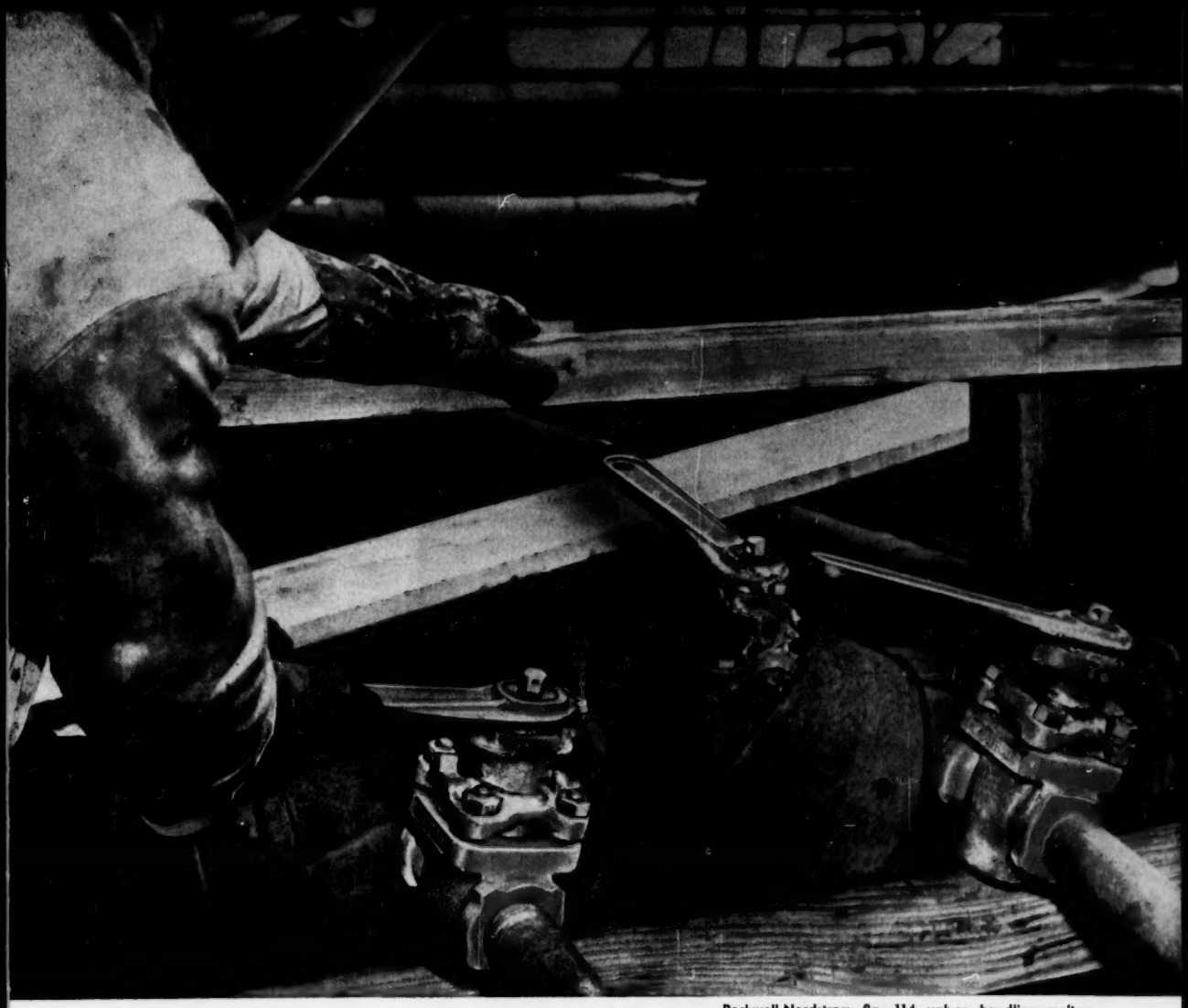


Five-ton-per-day Glasteel primary ClO_2 generator at Marathon Southern.

FLUIDICS AROUND THE WORLD

Pfaudler Permutit is a world-wide company with manufacturing plants in:
Germany: Pfaudler-Werke A.G.
Great Britain: Enamelled Metal Products Corp. Ltd.
Canada: Ideal Welding Co. Ltd.
Mexico: Arteacero-Pfaudler, S.A.
Japan: Shinko-Pfaudler Co., Ltd.
as well as four plants in the U.S.A.

*FLUIDICS is a new Pfaudler Permutit program that provides a modern, imaginative approach for handling and processing liquids and gases more profitably.



Rockwell-Nordstrom fig. 114 valves handling molten phosphorus at 84°C. Maintenance Superintendent says, "Maintenance has been absolutely nil for 5 years."

try THIS with ordinary valves

The Rockwell-Nordstrom *lubricated* plug valves shown above are handling molten phosphorus. They've been performing perfectly for *five years;* other valves tried on this service failed in *five weeks.* Isn't it logical that a valve capable of delivering outstanding performance in the *toughest* services is also your best assurance of longer valve life and lower cost on *any* service?

In Rockwell-Nordstrom valves, positive shut-off is assured by pressurized lubricant sealing between the valve plug and the body. *Since lubricant sealing is instantly replaceable,* it can't "wear out" like ordinary metal-to-metal seats. And vital seating areas are never exposed to the line. This means real cost cutting in terms of longer valve life and far lower maintenance.

Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves. Send coupon for details or have a Rockwell field engineer visit your plant. Rockwell Manufacturing Co., Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers, Limited.

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL

LUBRICATION MAKES THE DIFFERENCE

Rockwell Manufacturing Company
Pittsburgh 8, Pa.

Please send free booklet V-203 ☐

Please have your sales engineer call ☐

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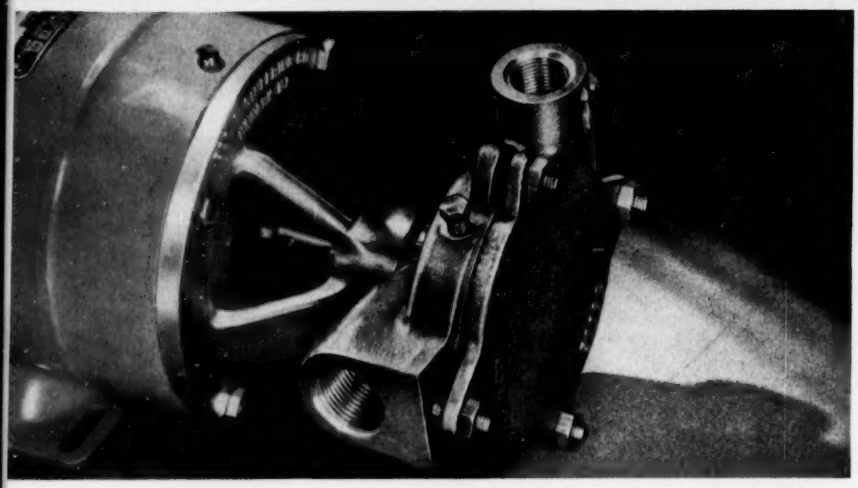
ECO ENGINEERING NEWS

VOL. 1, NO. 5

the big name in small pumps for the process industries



Close-coupled motor-mounted CENTRI-CHEM Pump.

Standard, Stock Centrifugal Pumps Handle Wide Range of Corrosive Media

Eco CENTRI-CHEM× Pumps feature Type 20 stainless steel throughout—casings, shafts and impellers—meeting a wide range of corrosion services.

Answer Standardization Needs

These pumps were designed to meet the standardization programs of major multiplant, chemical companies, but they offer equal advantages and economies to medium sized and small plant operators, requiring small centrifugals with capacities up to 40 g.p.m.

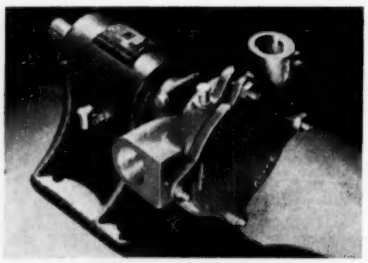
Manufactured on a precision, mass-production basis (instead of being "custom-built" as are most other chemical-resistant pumps of this type), costs and prices are kept low. Every part is interchangeable. Pumps and repair parts are stocked for immediate delivery, by air if required for emergency needs, guaranteeing the very miminum down-time.

Seal is Big Feature

In every centrifugal pump, the shaft seal is usually its weakest point. The exclusive design mechanical seal used in the CENTRI-CHEM Pump has proven leak-proof under the most severe conditions. It also has handled sticky fluids for many months where other seals have gummed up and failed in minutes. Seal components to meet various exposures, include TEFLON† and ceramic, carbon and ceramic, and carbon and Type 20 stainless or Stellite.* All seal components are interchangeable.

New Bulletin Just Released

Write for your copy of Bulletin CT-859 which describes these remarkable pumps in detail.



Pedestal-mounted CENTRI-CHEM Pump.

Pumping Notes

New Electrolytically Pure Nickel GEARCHEM Pumps

No other pump line is available in so many special metals and non-metallics, each with its own realm of application.

The Nickel GEARCHEM× Pump is designed to prevent iron contamination of bromine and other caustics. Casings and shafts are pure nickel. Driving gears are nickel or Hastelloy* with idlers of chemically impervious TEFLON.

This metal to non-metallic gear combination permits pumping of water-thin, non-lubricating fluids without seizing, at speeds to 1750 r.p.m.

New Phenolic Plastic Gears Resist Chemicals—Wear Longer

Advancement in phenolic resin plastics technology has made great strides in recent years. Results range all the way from ultra-high temperature resisting materials suitable for rocket nose cones, to new materials which are not attacked by such widely used acids as Sulphuric, Hydrochloric and Hydrofluoric, in all concentrations and combinations. These resins are unaffected dimensionally or chemically with exposure to these acids and numerous other corrosive and problem media.

Gears generated from this phenolic plastic are now recommended for long sustained, heavy duty service in Eco GEARCHEM Pumps for such chemicals, as they have proven mechanically stronger and show minimum wear. They may be used in pairs or as idler gears in combination with metallic gears.

Hastelloy B Pumps for Hot HCl Service

Eco GEARCHEM Pumps in Hastelloy B are expressly produced for HCl service in advanced temperature ranges (up to 160°F). Both the 3 g.p.m. and 10 g.p.m. sizes of GEARCHEM Pumps are available in this alloy.

Regularly supplied with TEFLON or carbon bearings and TEFLON, phenolic or Hastelloy B gears, and with grease-sealed extended stuffing box.

ECO Products for Handling Corrosive and Hazardous Processing Fluids

ALL-CHEM× Rotary Pumps
MINILAB× Rotary Pumps
GEARCHEM× Gear Pumps
CENTRI-CHEM× Centrifugal Pumps
PUMPMOBILE× Portable Pumping Units
CHEMICAL DISPENSING VALVES Factory Mutual Approved
GEAR-VAC× Valves

Ask for literature on any or all of these ECO Products

×ECO Trademarks. †du Pont Trademark. *Union Carbide Trademark.

ONE OF A SERIES

Printed by offset lithography on 80-lb. paper containing Wyandotte PURECAL® in the coating.

Who is the man in the technical service hat?

He might be an expert on Wyandotte's products for the paper industry.

He might be a specialist in the field of industrial glycols.

Or, he might be one of our men with the answers on Pluronic® polyols . . . or other urethane-foam chemicals.

But whoever he is, this much is certain—he has quick access to a vast amount of fundamental and pertinent information about our products which can be most helpful to you. This includes chemical and physical properties, product specifications, handling and storage practices and precautions, product limitations, and other such characteristics.

He also can arrange consultations with science-specialists* on specific areas of a product's application, and can furnish application data based on research and industrial experience, to help adapt any of our products to your formulations or processes.

This is all a part of our approach to technical service, which with us is a deep-rooted and sincere desire to be of help both *before* and *after* the sale. It is available to you, too. Just send us as much information as you can, and we'll set the wheels in motion.

For a pictorial presentation of Wyandotte technical service at work, please turn the page.

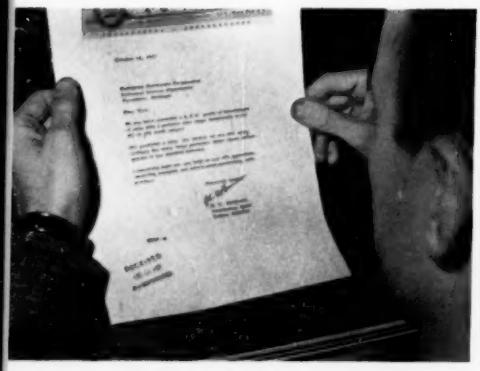
*Chemists, Chemical Engineers, Physicists, etc., whose industrial or research experience qualifies them as specialists in their particular field.

WYANDOTTE CHEMICALS

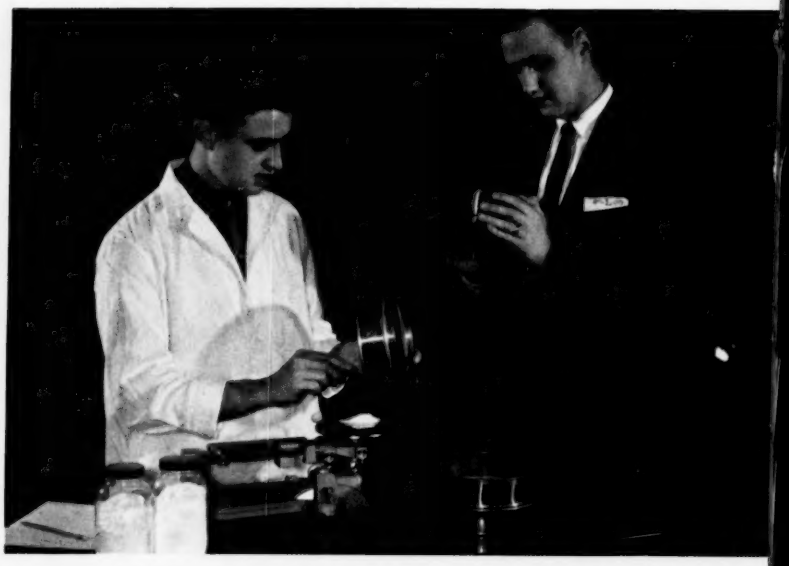
SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA • CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE • MURIATIC ACID • HYDROGEN • DRY ICE • GLYCOLS
SYNTHETIC DETERGENTS (anionic and nonionic) • SODIUM CMC • ETHYLENE OXIDE • ETHYLENE DICHLORIDE • POLYETHYLENE GLYCOL • PROPYLENE OXIDE
PROPYLENE DICHLORIDE • POLYPROPYLENE GLYCOL • DICHLORODIMETHYLHYDANTOIN • CHLORINATED SOLVENTS • OTHER ORGANIC AND INORGANIC CHEMICALS

Choosing the best grade of bicarb

. . . an example of Wyandotte technical service at work



1 "The bicarb we are now using," writes a West Coast producer of packaged baking goods, "appears to be the cause of brown spots in our cakes and biscuits. I sincerely hope you can help us." A sample of this bicarb was mailed to us under separate cover. This inquiry puts our technical service to work.



2 Laboratory screen analysis found both large particles and fines in the sample. A uniform product, with a controlled range of particle size, was needed. Samples of two grades, Wyandotte Better Blend Soda® and U.S.P. fine granular, were sent to the customer for evaluation and approval, along with a report.

3 The customer's plant superintendent visits Wyandotte's bicarb manufacturing facilities to see firsthand how these products are made. The technical service man shows him the various processes, pointing out how this optimum range of particle size in Wyandotte sodium bicarbonate is achieved and controlled.

4 Delicious! The technical service man follows up to make sure that the product has performed satisfactorily. He samples the new product . . . finds to his delight that the cake is high, light and tender, with uniform texture . . . a treat to the taste . . . and proof, in the eating, of a job well done.

Wyandotte
CHEMICALS

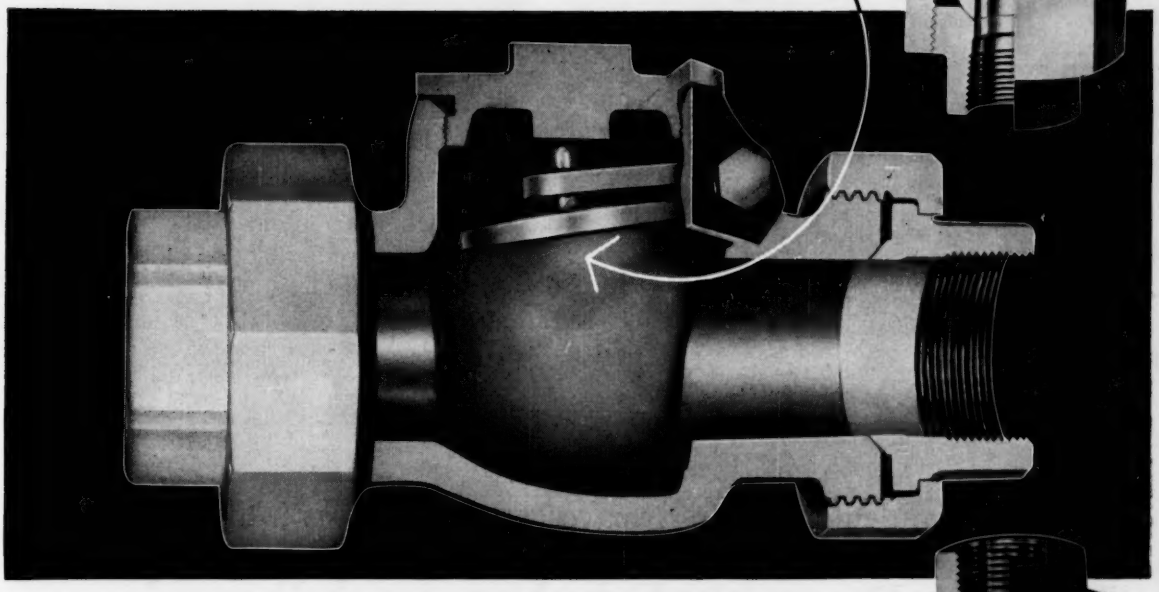
Pacing progress with creative chemistry

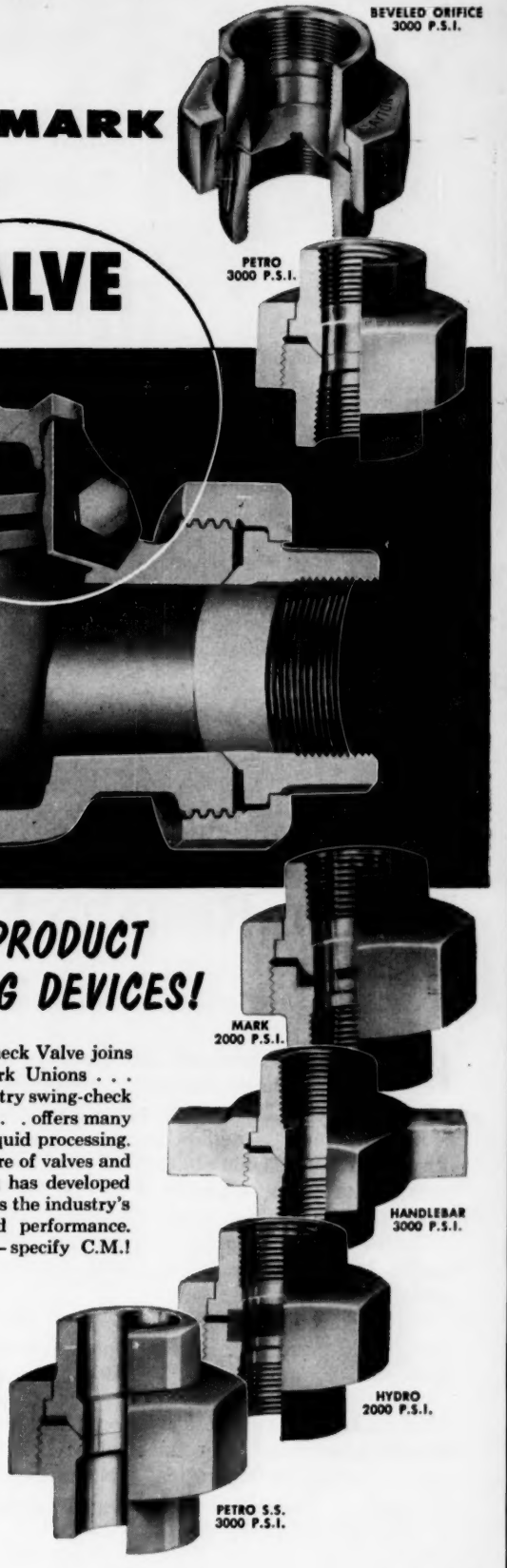
724

Perhaps you, too, are looking for ways to improve the quality of your products. Or perhaps you'd like to effect savings in your operations. Well, here's a worthwhile tip: Check with us if you have a problem that falls within our technological or manufacturing background . . . our approach is designed to provide answers. *Wyandotte Chemicals Corporation, Michigan Alkali Division, Wyandotte, Michigan. Offices in principal cities.*

Brand New!

CLAYTON MARK *full opening* UNION CHECK VALVE





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New *full opening* Union Check Valve joins the family of Clayton Mark Unions . . . bringing to industry a top entry swing-check valve with superior features . . offers many advantages especially for liquid processing. A pioneer in the manufacture of valves and steel unions, Clayton Mark has developed a complete line that serves as the industry's "yardstick" of quality and performance. When you want the best – specify C.M.!

Feature for feature CM Unions are superior!

CLAYTON MARK & COMPANY

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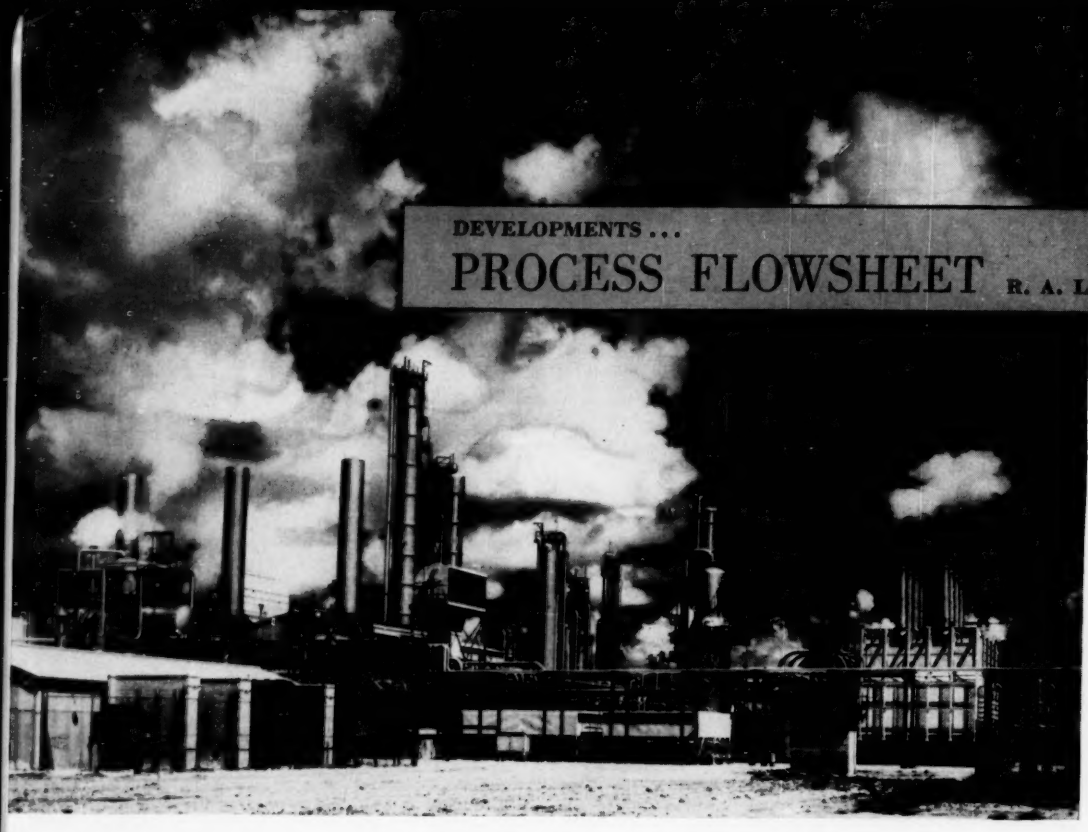


DEVELOPMENTS . . .

PROCESS FLOWSHEET

R. A. LABINE

Low-pressure demethanizing weaves process plusses into . . .

Modern Route to Ethylene and Propylene

PETROLEUM Chemicals, Inc., planning a probable expansion to full-scale production next year at its Lake Charles, La., petrochemical plant, is now making 200 million lb./yr. of high-purity ethylene and 15-25,000 bbl./mo. of propylene. PCI pegs ultimate plant capacity at 300 million lb./yr. of ethylene; propylene output varies with demand.

With its unique process, PCI produces ethylene specified at 99.7% purity and propylene of 95% purity.

Designed and built by Lummus Co., the plant departs in several respects from conventional routes:

• Low pressure, low-temperature demethanizing makes low refrigeration and reboil-heat demands, gives high thermal efficiency. Ethylene and propylene refrigeration systems supply reboil heat to demethanizer, reboil heat and reflux to ethylene and propylene fractionators.

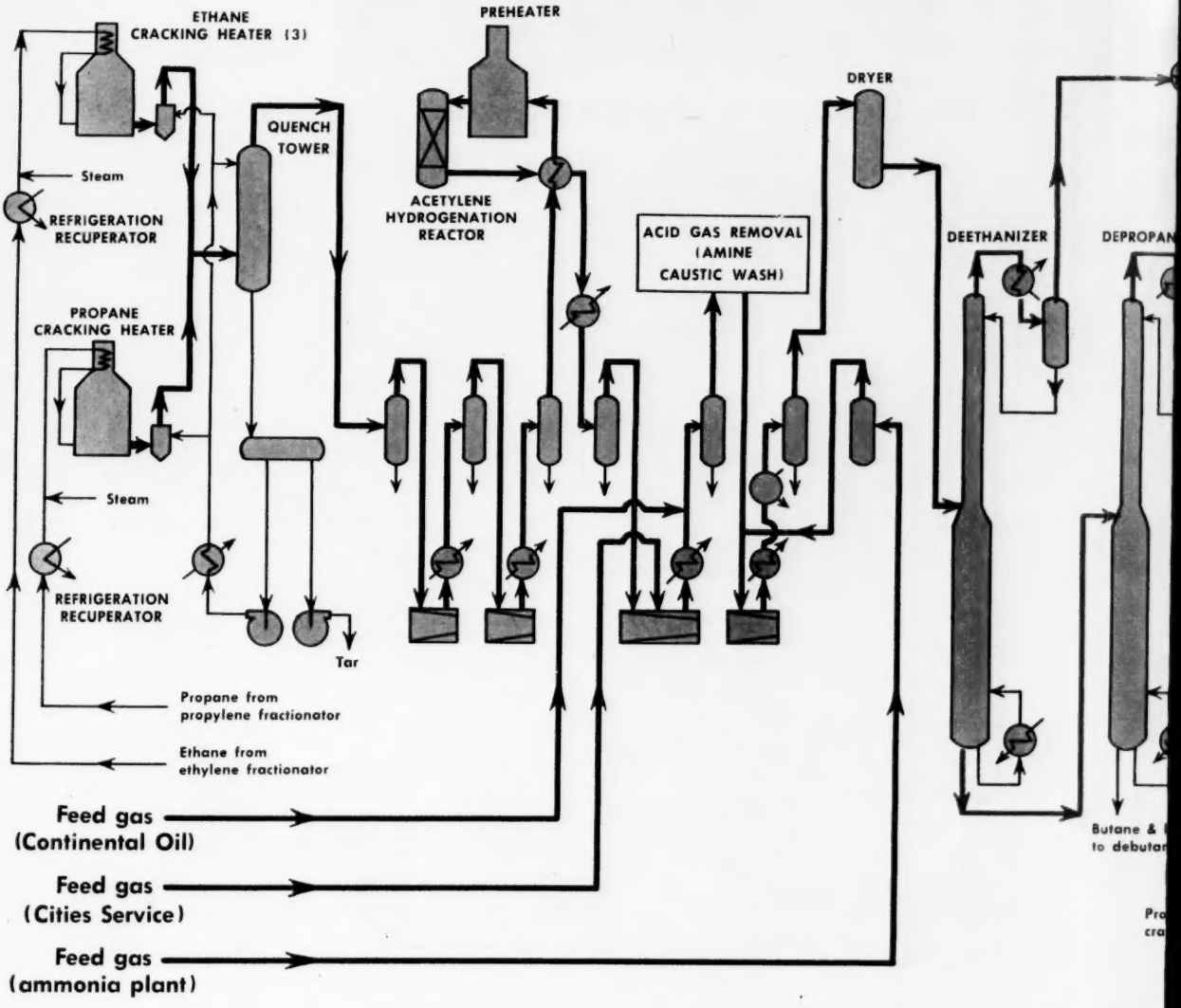
• In fractionating section, conventional routes usually feed gases first to the demethanizer at high pressure. PCI splits out C_2's and lighter, chills this steam to –130 F. and below, feeds it as liquid from two condensate drums to the demethanizer. This isolates demethanizer from process upsets.

• High-purity ethylene is produced with a single demethanizer and ethylene fractionator. No rerunning or topping facilities are required.

▶ **How Process Works**—Feed gases come from three sources: nearby refineries of Continental Oil Co. and Cities Service Refining Corp. and from PCI's own ammonia plant. Gases contain largely methane, ethane, propane and ethylene. Feed for expanded output will be ethane or propane from other sources.

At present, three furnaces crack ethane (previously reported at about 60% conversion per pass)

Unfold Flowsheet



and one cracks propane (reported at about 75% conversion per pass). Steam injected at the furnace inlets controls partial pressure and suppresses coke formation. Ethane leaves furnace at about 1,525 F. and propane at 1,490 F. Heaters will be added for the expanded plant.

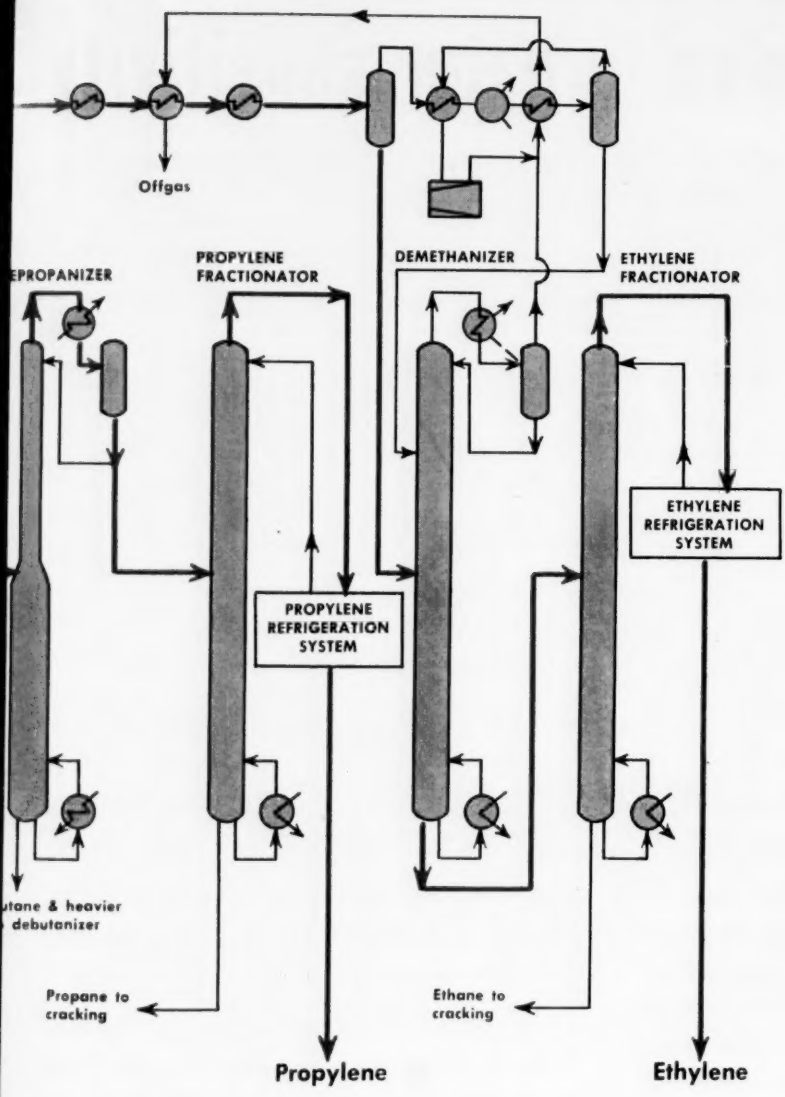
Heater effluents are water-quenched to about 600 F. at furnace outlets, combined and further cooled to 100 F. or less in a quench tower.

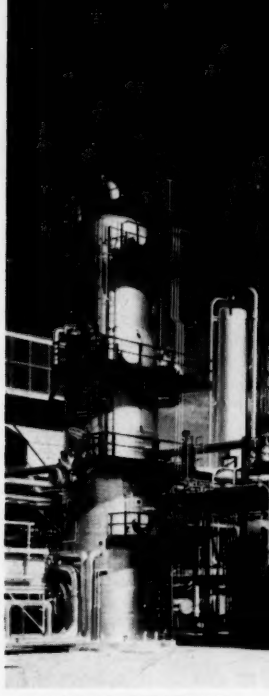
Quench water, subcooled by evaporating propane heater charge, circulates to the upper part of the quench tower and assures minimum gas temperature to the heater effluent compressors.

▶**Cool Compression**—Heater effluent, together with fresh feed gases, is compressed from 9.0 to 525 psig. by four tandem centrifugal compressors driven by a single combustion gas turbine.

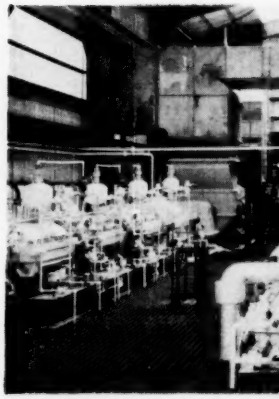
It's important, especially in the first two stages where heater effluent isn't diluted with fresh feed, to hold down compressor outlet temperatures. Therefore, compression ratios are low and water sprays reduce outlet temperatures.

▶**Remove Acetylene**—After the second compression stage, a hydrogenation reactor cuts acetylene





CRACKING HEATERS cra



COMPRESSORS shown here
Left to right: Compressors

oncentration to a maximum of 50 ppm. in ethy-ene product. Hydrogenation catalyst is regener-ted at regular intervals with air, steam and hy-rogen.

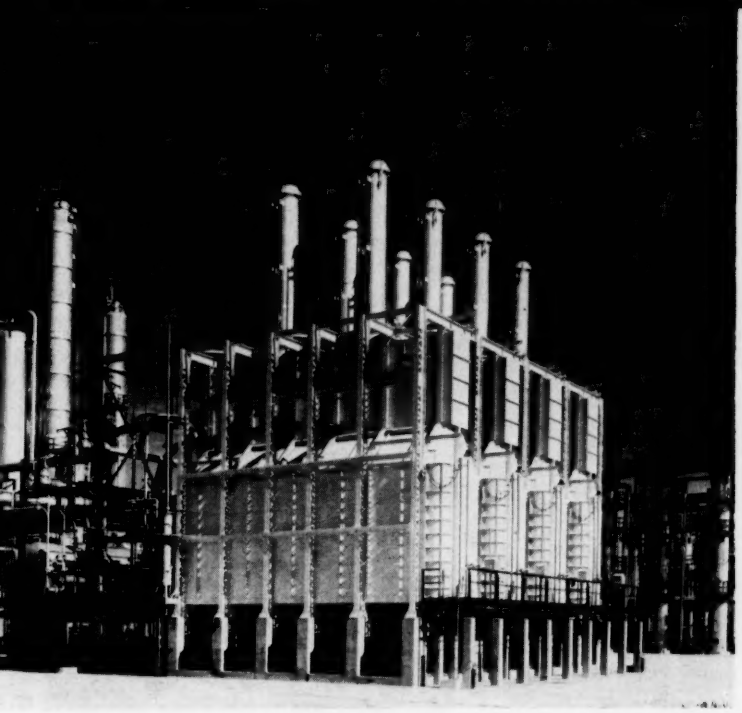
Contaminants—CO_2 and H_2S—are removed in n amine system followed by caustic and water rash. Ammonia plant feed does not require treat-ng.

After compression, gases are chilled by propy-ene refrigeration to about 60 F. or just above the ydrate-formation point. Liquid and vapor phases re separated, water decanted and hydrocarbons dried in liquid and vapor dryers. Dried liquid and vapor streams (the latter after further chilling) charge to the deethanizer operating at 490 psig. Bottoms temperature is below 200 F., so polymerization in the reboiler is no problem.

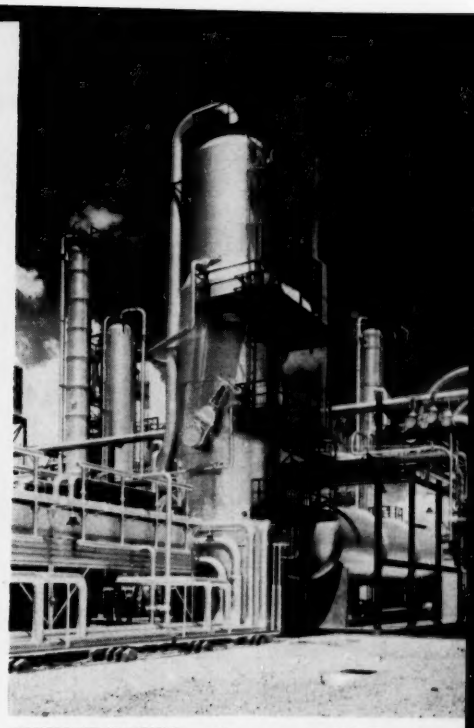
► **Processing C_2's**—Deethanizer overhead, containing hydrogen, methane and virtually all of the ethane and ethylene, is chilled by ethylene and propylene refrigeration and by exchange against offgas to –130 F. Now 95% of all C_2's and some methane are liquefied. Liquid goes to the demethanizer; vapor is chilled with offgas and

methane separated izer. With gas from ethylene.

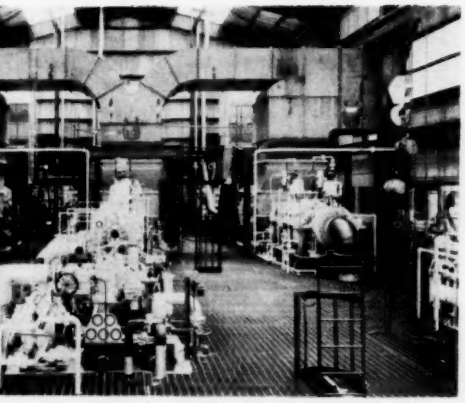
Demeth a small a Two liqui smooth ou ation in c ture of th free of C_3



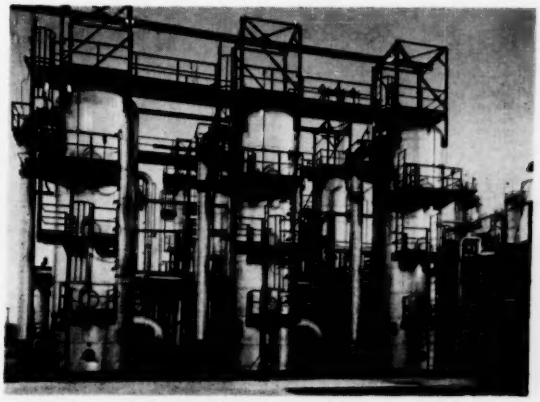
S crack ethane, propane. Tall towers are ethylene and propylene towers.



QUENCH TOWER cools gases to 100 F.



here are all driven by combustion gas turbines.
ors for charge and effluent, ethylene, propylene.



ACETYLENE HYDROGENATION REACTORS reduce acetylene to maximum of 50 ppm. in ethylene product.

ane refrigeration to –190 F. and the phases ated. Again, liquid charges to the demethan- With recovery now essentially complete, off- rom the demethanizer contains about 0.5% ene.

nethanizer, operating at 75 psig., needs only ll amount of reflux in rectification section. iquid surge drums that feed the tower can h out changes in feed composition or fluctu- in compression system. Overhead tempera- of the tower is –210 F.; since bottoms are f C_3, temperature is low (about –70 F) and reboiling is done by condensing ethylene refrig- erant. Demethanizer bottoms flash into ethylene fractionator operating at 50 psig.

Ethylene tower overhead vapors combine with ethylene refrigeration vapors, are compressed and condensed in the demethanizer and ethylene tower reboilers. Refrigeration surge drums supply tower reflux. Ethylene product is compressed, condensed at the compressor discharge, pumped to 1,100 psig. and is delivered to the product pipe- line after reheating. Low-purity ethylene may be withdrawn as a sidestream from the tower.

Chemical Show • Booth 1002
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*manufactured by welding to obtain length

These are just a few of the reasons it pays to specify B&W Job-Matched Stainless Steel Tubing. Call your local B&W District Sales Specialist, or write for Bulletin TB-355 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

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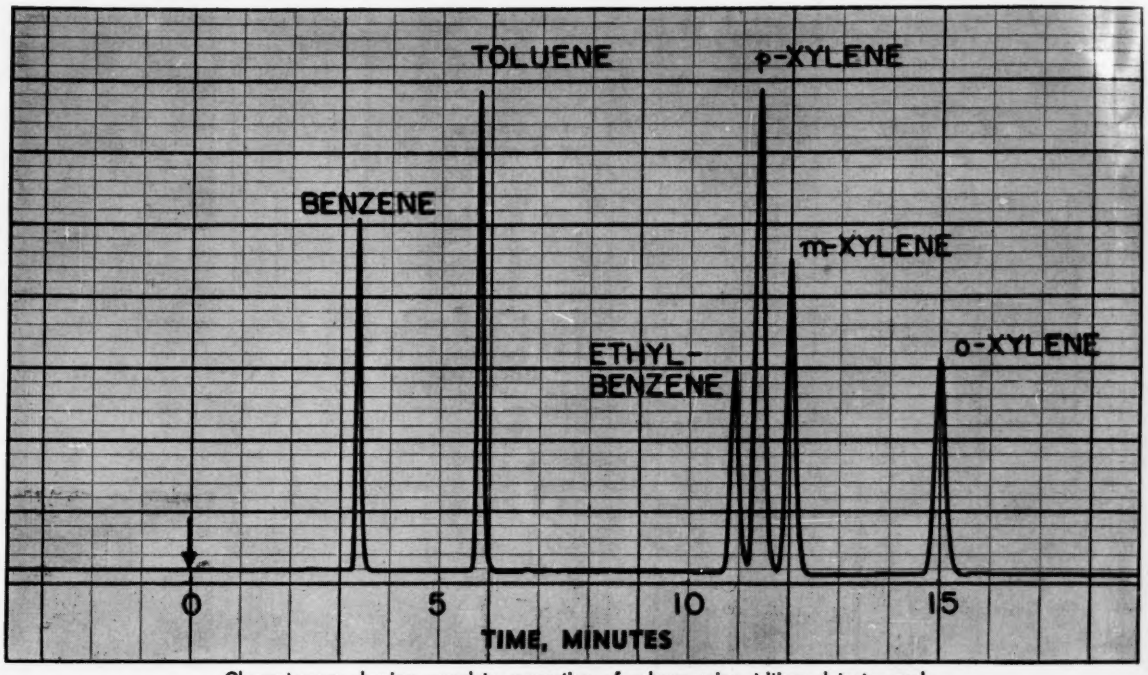
***Another* Wheelco *first*—**

New tritium detector means less base line noise, greater sensitivity



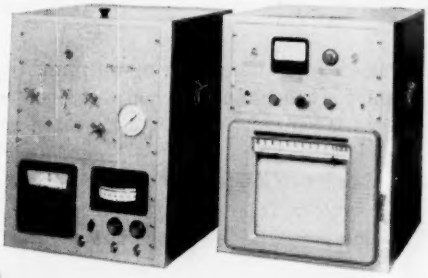
Chromatogram showing complete separation of xylenes using tritium detector and 60-ft stainless steel capillary column. Temperature, 67°C; flow rate, 0.7 ml/min Argon.

Now Wheelco offers a new tritium detector — to 225°C — in addition to the time-proved ionization detectors using strontium 90 and radium. Sensitivity is greater because tritium detectors have less base line noise than any other radioactive source: 1/3 as noisy as strontium and 1/30 as noisy as radium.

With a tritium source the detector offers the ultimate in simplicity and can be cleaned regularly. Long life with practically no maintenance or replacement is assured.

Outstanding operating flexibility is provided because the same detector can be used for capillary or packed columns.

See Wheelco first before selecting any chromatography equipment. New developments based on extensive field experience keep Wheelco ahead of the rest.



Model 20 is a compact, portable unit designed to use both capillary and packed columns. Wheelco also builds the Model 10, a laboratory unit for single or dual operation.

THE MARK OF QUALITY

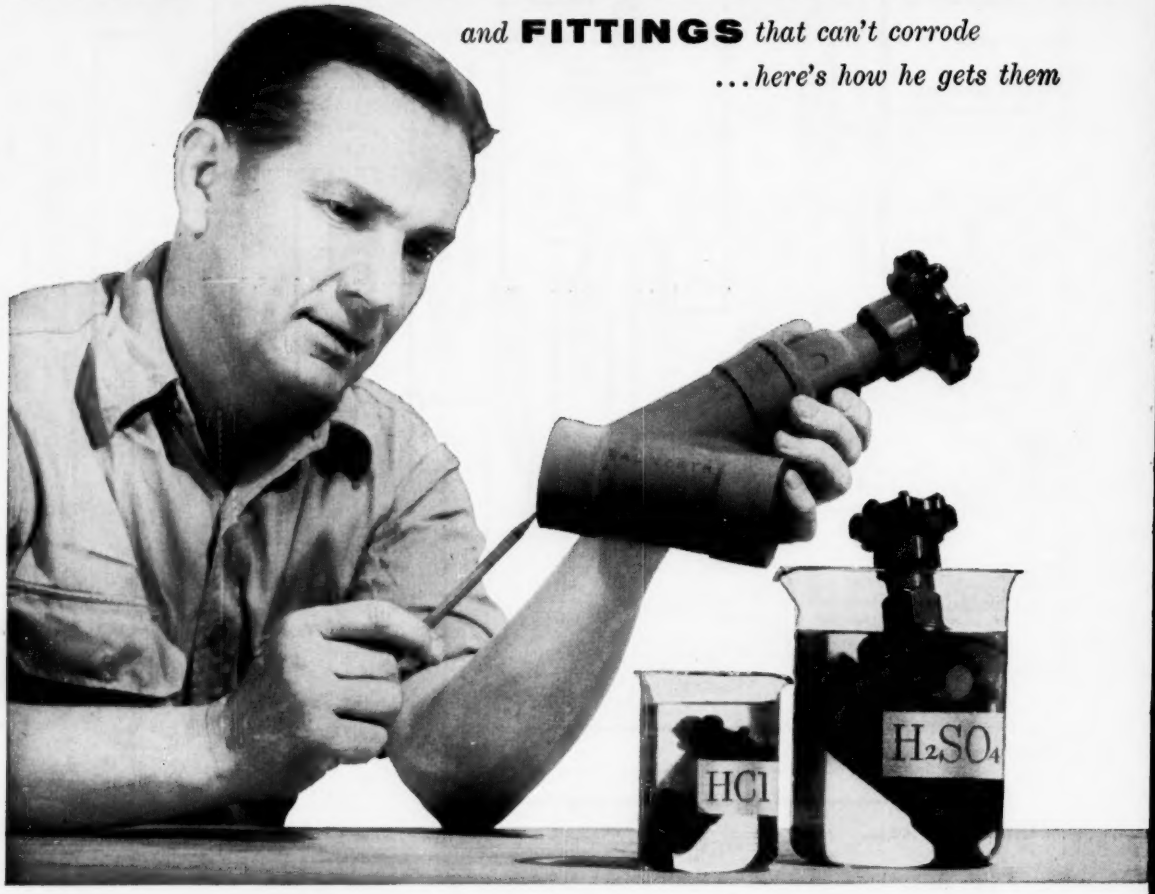
BARBER COLMAN

Wheelco Instruments Division

BARBER-COLMAN COMPANY

Dept. V, 1585 Rock Street, Rockford, Illinois, U.S.A.

the **WALWORTH CUSTOMER** *wants* **PLASTIC VALVES** *and* **FITTINGS** *that can't corrode ...here's how he gets them*



When the Walworth Customer is faced with the control of corrosive fluids, he looks at dozens of plastic valves and checks them for himself. He demands answers to questions like these: Can this valve corrode? Is it toxic? Is it non-aging? In Walworth PVC Valves and Fittings, the Walworth Customer finds his answers. Not only is PVC nontoxic and non-aging, – it *can't* corrode. *All* parts are made of plastic. Valves and fittings have high burst strength. Given those facts the Walworth Customer buys.

That may be the way you like to buy valves, too. If you insist on knowing about materials, workmanship and high quality, we'd like you for a Walworth Customer, too. For the newest literature on the complete line of PVC Valves and Fittings, get in touch with your Walworth Distributor.

Or write **WALWORTH** *750 Third Avenue, New York 17, N. Y.*

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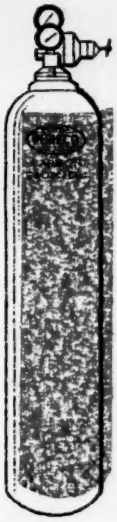
WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.

PURECO CO_2



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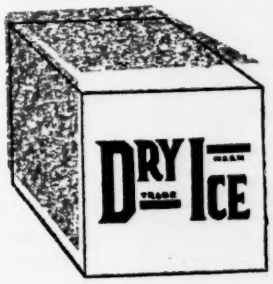
Investigate CO_2 as an Inert Gas for

pharmaceuticals
paints and dyes
packaging
purging and blanketing
inert pressure transfer
explosives
powdering



Use CO_2 as a Refrigerant for

pharmaceuticals
grinding, plastics, resins, gums, etc.
rubber tumbling
vacuum traps
low temperature testing
lyophilizing

Specify CO_2 as an Ingredient in

pharmaceuticals
ph control
foam rubber
asbestos cement cure
carbonation
foam plastic
water treatment
manufacture of carbonates

Pureco CO_2 is quickly available – in solid "DRY-ICE", liquid or gaseous form from over 100 sales and service depots. There are also a variety of Pureco CO_2 supply systems available – cylinders – cylinder banks, converters, receivers – each "tailored" to fit your particular requirements.

Pureco Technical Sales Service is qualified through its research in the field to assist you in adapting CO_2 to your particular process. Call Pureco today.

PURECO CO_2

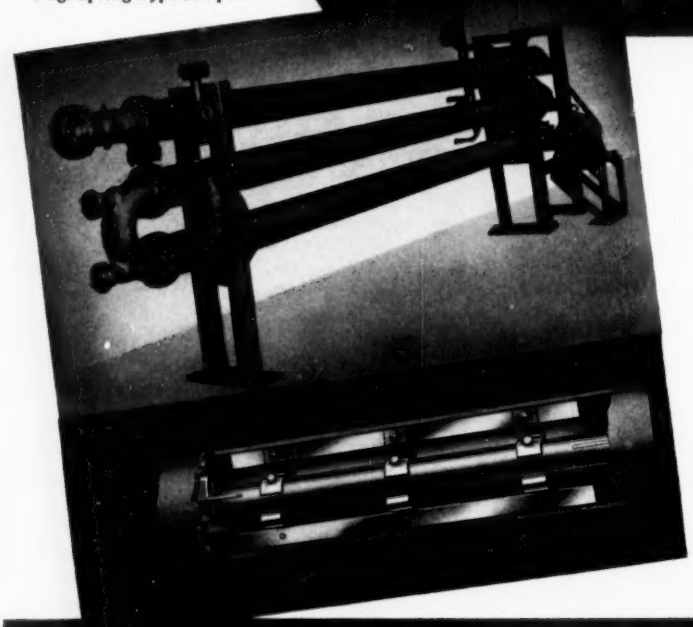
Pure Carbonic Company

A division of Air Reduction Company, Incorporated
150 East 42nd Street, New York 17, N. Y.

AT THE FRONTIERS OF PROGRESS YOU'LL FIND AN AIR REDUCTION PRODUCT

Vogt Solve EXCHANGERS Heat Transfer and Crystallization

BELOW: *A scraped surface unit for production of Para-Xylene by fractional crystallization. Insert shows detail of Vogt Spring Type Scraper.*



. . . And Here's How:

1. Rotating scraper action continuously sweeps surfaces clean even while processing highly adhesive materials.
2. Uniform rate of heat transfer keeps crystallization under control and discharges crystals as a slurry.
3. Product is thoroughly mixed by scraper blades as it flows.
4. Closed, pressure-type system permits use of flammable, volatile and expensive solvents with complete safety and no solvent loss.
5. Units fabricated from a broad range of materials to suit process stream characteristics.

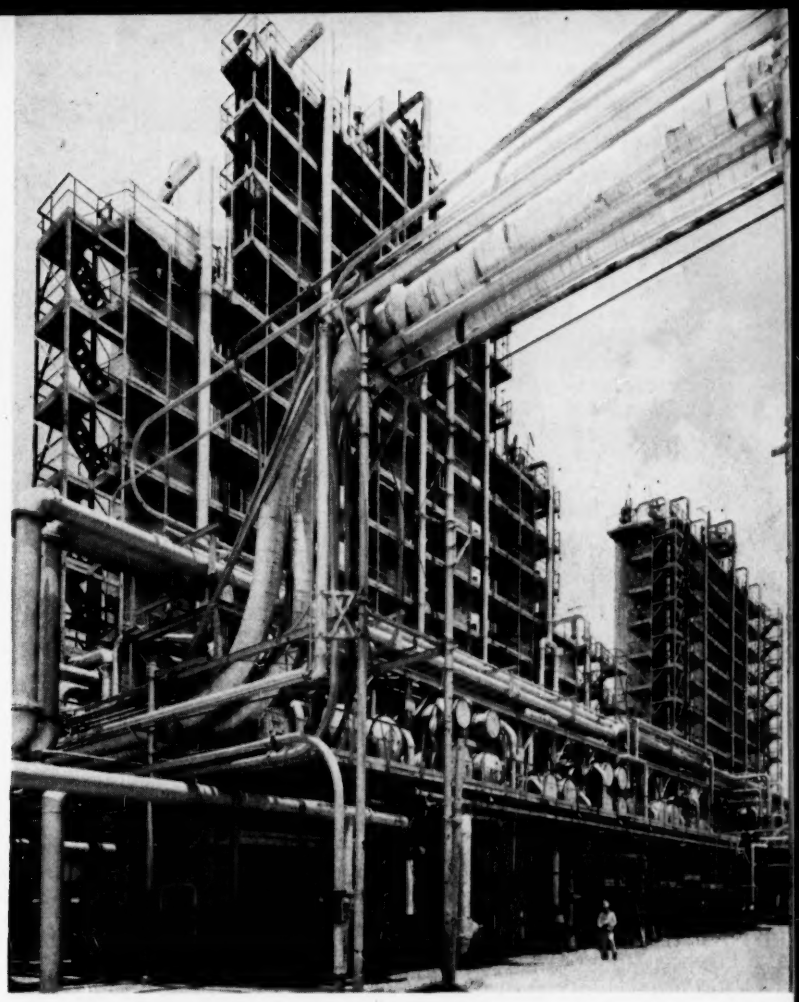
Write for Literature. Address Dept. 24A-XC

Listed here is a wide variety of materials which have been successfully processed with Vogt Scraped Surface Exchangers in the chemical, petro-chemical, petroleum and related industries.

Benzene Hexachloride
Caustic Soda
Caustic Potash
Clay
Cylinder Stock
Para-Dichlorbenzene
Fatty Acid Solutions
Fish Oil
Linseed Oil
Naphthalene
Paratone & Solids
Phenolic Resins
Polyester Liquid
Pressed Distillate
Reduced Petroleum
Waxy Oil-Solvent Mix
Soybean Oil
Sperm Oil
Sugar Syrup
Sulfur-Oil Mix
Sulphate Solution
Tall Oil-Naphtha-Sulfuric Acid Solutions
Tetrachloro Benzene
Viscose
Wax Slurry
Para-Xylene

HENRY VOGT MACHINE CO.
Louisville 10, Ky.

Chemical Engineering
OCTOBER 5, 1959



Speculative Process Design

Abandon precision as an early objective. Intensify the search for key mechanisms. This novel approach may reduce—even eliminate—engineering research cost.

DONALD Q. KERN, D. Q. Kern Associates, Cleveland, Ohio

A DECISION to abandon a plant-design research project several years after its initiation confronts the engineering-research administrator with one of his most unpleasant responsibilities.

In many cases the decision involves a multitude of implications both scientific and humanistic. It may even entail the reversal of a considered judgment with a permanent loss of personal prestige.

This report describes a speculative approach to engineering research and full-scale process design that can reduce the incidence of these dead-ends. The speculative approach is inexact; and it makes use of certain informalities and liberties during the research program which should be admissible as part of the scientific method, although they currently enjoy relatively little popularity.

A speculative approach differs from conven-

tional concepts in that it does not have precision as its early objective, but only eventually achieves it when it proves necessary—and then only sparingly.

It is a mathematical procedure which devoutly uses experimentation for the purpose of confirming mechanisms rather than the wholesale production of tabulated numbers and conclusions that come after them.

Sound Start at Lower Cost

Positive aspects of a speculative approach lie in the assurance that a plant-design research project will get off to a sound start at a lower cost, rather than provide a precise answer later.

After all, it doesn't really matter how precisely an answer is obtained if it proves to have no further application.

More important, it's often possible to determine definitively, and without much cash outlay, whether it pays to bother starting a program at all. Everything is focused at the outset on the two principal nemeses of every project: running out of funds; and/or running out of reportable technical progress.

Reverse Thinking Essential

First essential step in the speculative approach may be called "reverse thinking."

Consideration is not given to the small-scale plant from which data will evolve for the design of a large-scale plant. Instead, attention is directed toward the design of a large-scale plant at the very outset of a project.

Only those small-scale experiments which can be used on the large scale are designed and carried out. In practice this produces many broad gaps which must be plugged. But it eliminates the preference for performing easier experiments rather than useful ones.

The continuity of effort outlined here was born, admittedly, of hindsight. It originated from first-hand reviews of a number of experimental thermal-research programs which declined from the pinnacle of hope to the threshold of abandonment.

Some were abandoned because they never had anything to prove! A few of the many rescued projects are included in the concluding section of this report as illustrative examples.

There are a number of useful empirical tools that facilitate the collection of the greatest amount of process plant design knowledge from a limited amount of experimentation. Recent articles in *Chemical Engineering*[1] and texts[2, 3] have directed attention to similarity criteria.

This is an excellent recommendation. But it concentrates attention on the act of correlation rather than the appraisal of the basic novelty of a physical or chemical system, or the need for the experiments and the competence of the design.

The Speculative Approach

There is much to be learned about a physical or chemical change simply by a mathematical statement of the mechanisms possible within it. This can be done through mathematical analysis with particular use of differential equations.

For example, we know that under certain conditions electrical systems and hydraulic systems obey analogous differential equations. Why not carry out the required experiments confidently in the more convenient system?

Diffusion of matter and conduction heat transfer are also described by similar characteristic equations. Mechanisms provide, by far, the most unlimited opportunities for confident chemical plant scale-up.

However, before borrowing differential equations it must be established that they also obey the same boundary conditions before they qualify as analogs.

Occasionally there is difficulty identifying any mechanism at all and you have to speculate from scratch. There's no need under these circumstances for even a precise starting speculation. In fact, it's often advisable to throw in a few extraneous factors which should be self-liquidating when hypothetical boundary conditions are imposed.

No Apology Intended

It's not my intention here to offer apologies for the speculative approach because of the small premium it places on early precision, or the possibility that it will promote a new low in sloppy research.

The speculative approach will develop a cost-conscious research which endeavors to obtain an answer that is only as good as required—and no better. The requirement keeps changing as the project continues.

From this point of view precision is very often undesirable, particularly when it becomes a fetish. At the start of a project it consumes funds rapidly and slows progress with irrelevant considerations for such things as reproducibility, calibration and deviation when the only thought should be: "Can it be made to work?".

This represents a separation between the qualitative and quantitative research phases. And before it's reached the principal effort should be mental rather than physical.

A professional designer of plants, enjoying the responsibilities of a wife, children and a mortgage, will not use experimental information without some personal adjustment. To make a tenfold or twentyfold scale-up he will not select similarity ratios of 10:1 or 20:1. Most likely the design of the prototype will include 20-50% excess fat.

The designer's only concern is that he is providing the fat where he believes it is. For this type of design he only requires an indication of a response direction, rather than a collection of highly refined and costly data.

Furthermore, since it's rarely possible to preserve all aspects of similarity (in a plant of moderate complexity) during scale-up, the need for precise small-scale data is further reduced. Precision on the small scale may very well lose its significance as soon as scale-up is undertaken. In some instances it may be unique to the small scale.

Conceivably, the design sequence from pilot to prototype may even eliminate the need for highly calibrated measurements at any stage of development.

See Some Blind Spots

Unfortunately, there are many blind spots in the speculative postulation of a mechanism by differential equations. Some of the common equations lack straightforward solutions.

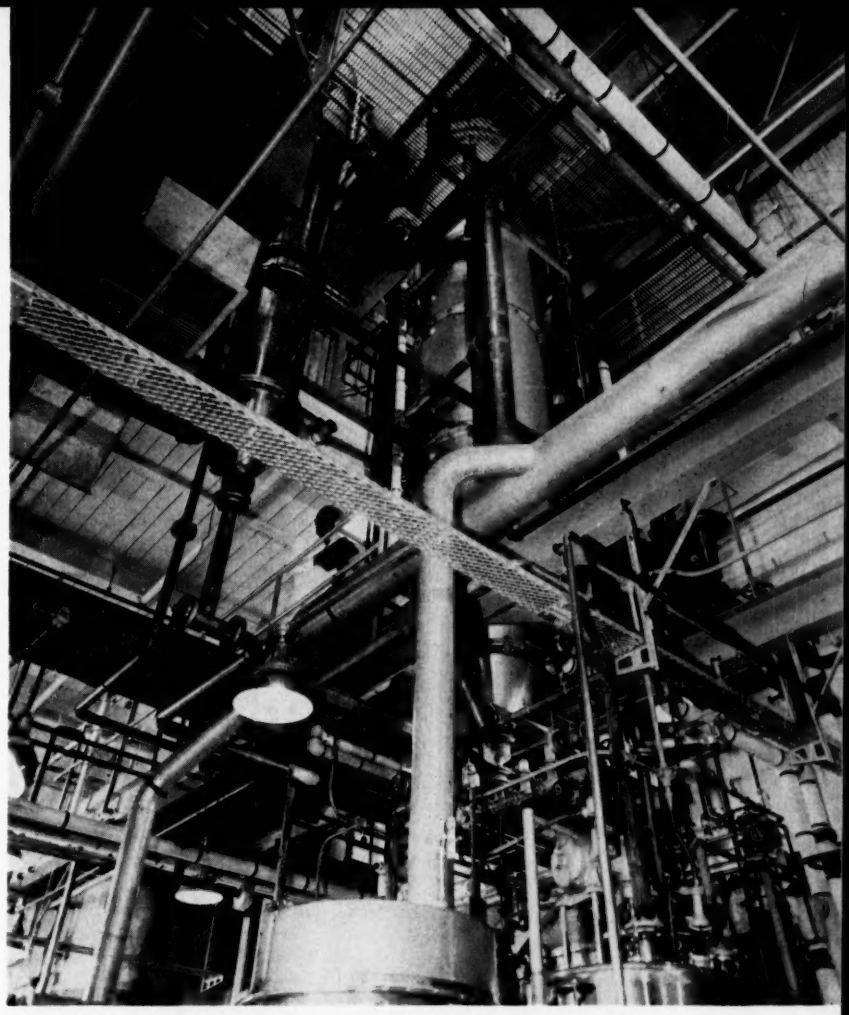
Perhaps this has discouraged the best advancement of effort in many cases before experimentation was begun, and has left no other course

open but short-range empiricism.

All roads beckon toward empiricism and it will be shown later in this report that even here differential equations themselves provide many introspections along these avenues.

Short-range empiricism, in its lower forms, merely produces a point per run on some sort of graph, or another entry in a table of data. These appear to be short odds for a large investment since the method sheds little light, if any, on mechanism, a point so essential to the design of large plants from small ones.

All signposts point to the *a priori** approach for clicking off the most miles per unit of cost. In fact, it's the next best thing to being lucky, and more consistent!



HOW MUCH RESEARCH effort went into this full-scale design?

The Case for Similarity

Through the speculative postulation of mechanism, it's often possible to reduce the research time requirements significantly. However, it would be unwise to overlook the advantages contained in the simpler aspects of similarity theory, even when unassisted by differential equations.

In the case of ultimate simplicity, similarity theory only requires the assembly of one bench- or pilot-scale component of a process, rather than an entire process, and the performance of a single experiment. This would occur when you want to build a component just like the pilot plant with respect to perhaps a single index of similarity, say geometrical similarity.

Because of fabrication limitations, not all components can be scaled-up economically while preserving similarity; nor would this be desirable from the standpoint of plant layout.

When additional indices of similarity are superimposed such as mechanical, kinematic or thermodynamic similarity, it may also be impossible to scale-up because of inconsistencies in the demands of the different criteria.

Requires a Probe

When it appears that too little is known about a system to warrant scale-up on the basis of similarity, the situation obviously requires a probe.

It's not possible to conduct an intelligent quantitative measurement of all significant effects without knowing what to look for beforehand or to what extent the instruments should be calibrated.

A probe is the identification of response variables such as physical properties, temperature, pressure, surface, etc. This identification should be carried out, preferably, inexpensively on a tiny bench scale. The tests require little or no precision and often a qualitative response is enough.

Compare all of the responses obtained with a catalog of the variables of other systems containing the same variables, plus others, to observe whether a test or property may have been omitted. This is easily done with punched cards and may be the first step toward determining that the probe system and other systems may indeed possess important mechanism similarities which were not apparent previously.

Then it's possible to proceed with techniques.

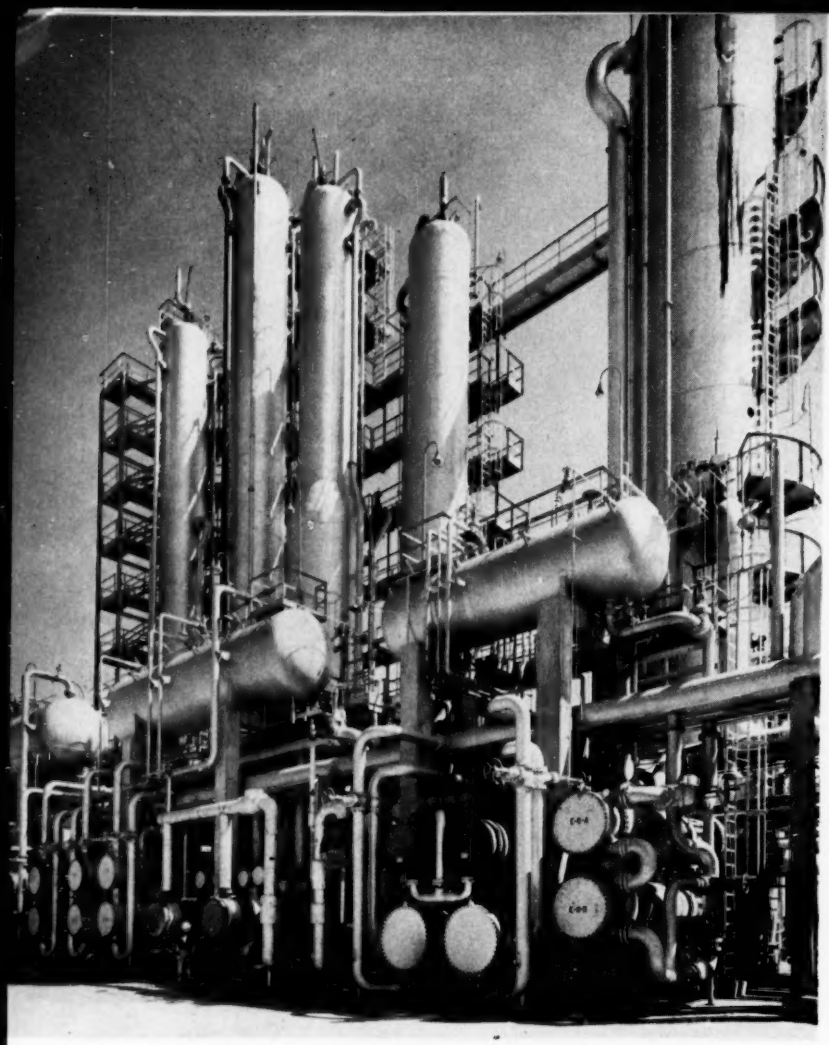
How Similarity Started

Froude[4] is generally conceded to have erected the first milestone in mechanical similarity, and hence in isothermal scale-up technique.

By drawing a model of a ship's hull across the free surface of a test basin at a given velocity, data were obtained which were used successfully for the design of large ocean-going vessels.

The next important development followed within a few years when Reynolds[5] investigated streamline flow in closed, full-flowing conduits. Both Froude and Reynolds were able to establish criteria of similarity by noting that in both systems the ratio of internal force to the frictional force acting on an element of fluid was everywhere constant.

*Characterizing that kind of reasoning which deduces consequences from definitions formed, or principles assumed.



SPECULATIVE APPROACH has been used successfully to design the heat exchangers serving this chemical process industry plant.

In Froude's case the resistance force was due to the gravitational pull on the hull. He defined the ratio of the two forces this way:

$$\frac{\text{Inertial force}}{\text{Gravity force}} = \text{a constant} = (\rho V^2/L)/\rho g = V^2/gL \qquad (1)$$

where L is an arbitrary length dimension; and the last term is generally referred to as the Froude number, N_{Fr}.

Reynolds considered his system to have no free surface, so that the action of gravity was nullified by buoyant equality. The ratio of the two forces for this case is:

$$\frac{\text{Inertial force}}{\text{Frictional force}} = \text{a constant} = (\rho V^2/L)/(\mu V/L^2) = \rho VL/\mu \qquad (2)$$

where the last term in the equation is the familiar Reynolds number, N_{Re}.

From this we see that the Reynolds number, although dimensionless, describes a ratio of forces in a system of forces without defining the actual numerical value of either force.

Theory of Similarity

A system of dimensionless ratios, or groups, may frequently be obtained very simply compared with a mathematical analysis which would be obliged to treat the absolute order of magnitude of both of the forces. For this reason, the handling of dimensionless groups has been collected into an area of analysis called the *theory of similarity*.

Dimensionless groups and *dimensional analysis* should not be mistaken as identities. The resolution of effects into dimensionless groups places the matter on a basis of ratios which are independent of the size of the system.

Dimensional analysis is simply one of the several algebraic techniques available for manipulating the dimensions of variables to achieve dimensionless groups.

Under the theory of similarity one has first learned (from perhaps the tiny bench-scale probe) those independent variables which appear capable of causing a response in a dependent variable. It is then possible to arrange all of the variables into dimensionless groups as described above.

The experimenter can now operate upon these groups by either of these two methods:

- The theory of models.
- The refined theory of models, using a power function.

His choice of method depends on the number of constants he is willing to evaluate by experiment. The simpler method is the theory of models.

The Theory of Models

Model theory states that if a general relationship exists between a single dimensionless group N_1 and other dimensionless groups, such as N_2, N_3, N_4 . . . N_n, so that

$$N_1 = f(N_2, N_3, N_4 \ldots N_n) \qquad (3)$$

then N_1 must be fixed by the numerical values of the other dimensionless groups, taken in any manner and regardless of the form of the function f.

When you want to determine N_1 for a large-scale process, simply establish a model or pilot plant in which all of the groups on the right side of Eq. (3) bear the same numerical relationship to each other as those in the large-scale plant. Accordingly, this procedure requires but a single test and gives but a single value for N_1.

The theory of models commends itself by its simplicity. Its great shortcoming lies in the fact that it never identifies the function f and hence never identifies the mechanism; or the relative contribution of the individual variables which one may wish to change from time to time. This is a serious limitation in the development of quantitative design information.

Rarely does one want to design an industrial plant which will obviously look like an overgrown pilot plant and possess all of its limita-

tions. In the industrial plant additional funds will be available to incorporate many elements of design which will give the production plant greater operating economy and permanence.

This means that in numerous respects it will not be desirable to have the prototype follow the model too closely. Variations will be introduced at the industrial design stage which, perhaps, cannot be studied in the model. The elimination of this latitude in the simpler theory of models may be completely restrictive.

The fact alone that a pilot plant has been assembled and paid for places little premium on the value of an answer obtained from a single run on a single experimental configuration.

A Second, Refined Approach

The second approach under the theory of similarity is a refinement of the theory of models using a function f in the form of a power series.

If a dependent variable is expressed in terms of its independent variables, the independent variables can be arranged in a succession of dimensionless groups that simulate the pure magnitude of a group containing the dependent variable.

This requires the evaluation of one or more additional constants for each term in the series until the desired experimental deviation is reached.

The pilot plant required for this kind of information may differ considerably from the one tested by the theory of models. Such a pilot plant will allow for the handling and measurement of changes in the variables and the program of experiments will be longer, of necessity. (But this may be inconsequential beside the original cost of assembling the pilot plant.) The exponential values of the variables in each of the dimensionless groups obtained by dimensional analysis will also be indicated.

This method of pre-analysis is of great importance in the calibration of the measurements by which the variables in the group will be observed. Also, it can lead to the accumulation of relatively good design data from a limited number of experiments.

For example, if one variable influences a group to the $4n$ power and another to the $n/4$ power, and the exponent of the group is greater than zero, the end result will be only about as good as your ability to calibrate the variable with the $4n$ exponent. In this form similarity theory cannot tell why an independent variable influences a result, but it can give an excellent indication of how much it influences it.

One Great Limitation

The power series approach has one very great limitation. It is essentially a tool for interpolation only.

Suppose one is to design a large plant engaging a large group of measured variables over a very wide operating range. It may be too costly to reproduce the entire range of variables in the pilot plant, although they may be economically available in the proposed large-scale plant.

In order to become familiarized with the contributions of the individual variables and the dimensional groups into which they may be resolved, a range of experimental variation must be established.

There is also the matter of data displacement which is incidental to the use of plant design data. Research results are usually correlated in terms of the mean value with a notation that identifies the mean deviation of the data.

However, the mean value has little worth in design calculations since the curve or equation so obtained must be juggled upward to provide a measure of assurance that all or most of the deviations are negative.

At the full-scale design stage no engineer is interested in learning whether or not a plant will work. Instead, he wants to make absolutely certain that it will.

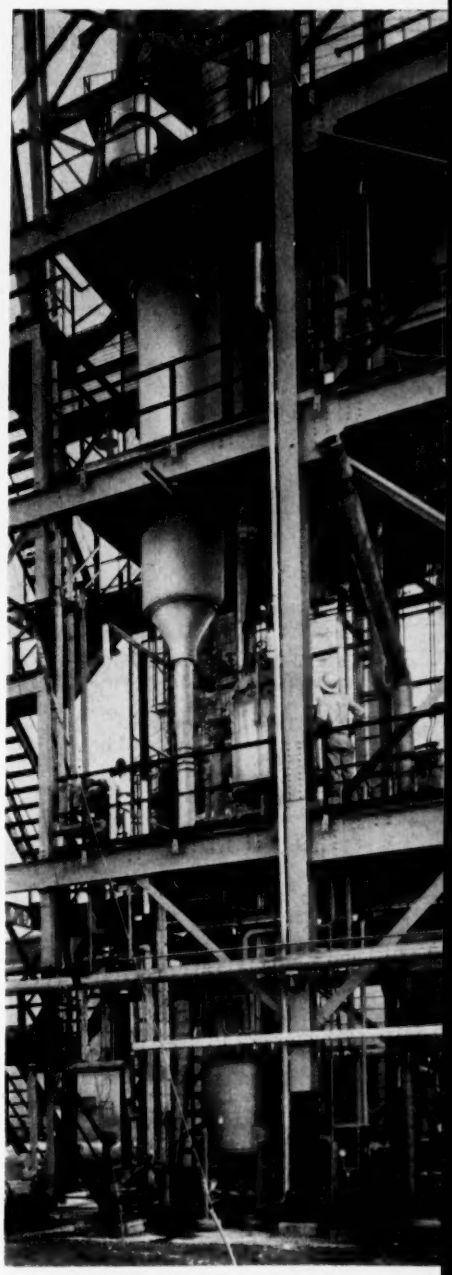
The curve-juggling phase may prove to be the most important step in the entire scale-up sequence.

In addition, the true function being investigated may pass through a maximum value. However, the range of experiments may only encompass the ascending or descending slope of a two-dimensional curve.

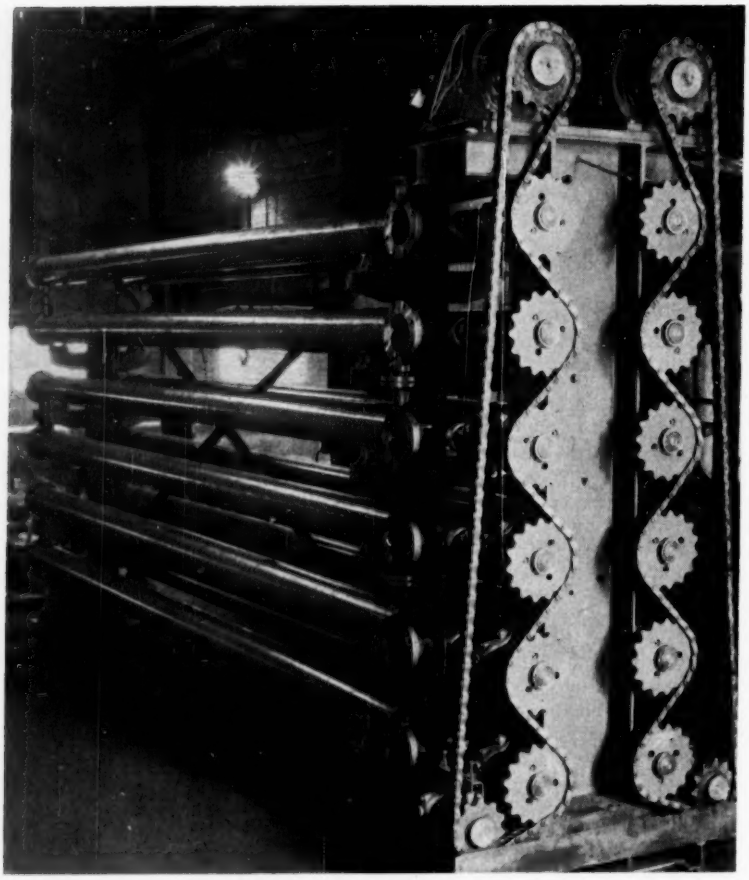
When the data yield a graph with a small average deviation in some coordinate system, the impression may be given that one is measuring a simple line function in the coordinate system.

There is often a need or a temptation to extrapolate experimental data.

When the pilot-plant data are extrapolated to the industrial scale, it's possible that experimental data are used in which the inversion



FULL-SCALE thermal processor designed from key mechanisms.



SCRAPED-SURFACE HEAT EXCHANGERS scaled-up to cool a fairly high viscosity polymer in a synthetic textile plant.

at the maximum was never approached — and the extrapolated plant might never actually work. Remember, you are always gambling when you extrapolate similarity correlations, and you may be giving the long end of long odds. A mathematical function can become discontinuous awfully fast.

There are a number of instances of just this kind of thing: the scaled-up plant that laid an egg because it could not be scaled-up retaining all criteria of similarity and could not produce the rated capacity with the proposed investment and operating costs.[8]

The Case for Mathematics

Mathematical analysis should serve as the first "dry run" in proposing a mechanism for a system.

Mechanisms, we note, are the things that can be scaled-up quite freely because they get to the core of things. It should be determined whether there is something new to be learned through experiment, or whether a program will merely reconfirm with a new assembly of hardware—and another fluid—a type of response which is already well known.

Postulate your prediction on the relatively invariant laws of physics and chemistry, and in a form that will possibly be amenable to computer simulation. Never hesitate to borrow data on analogous systems described in the literature.

It's surprising to observe that when real boundary conditions are imposed upon the postulation—however abstruse the mechanism may be—much information may be revealed. We might notice, for example, that a great increase in the only variable directly commensurate with operating cost cannot materially increase the yield of a chemical reaction or the efficiency of a mechanical system.

If increased yield or efficiency are the principal objectives of the program, one would best abandon further thoughts about constructing a pilot plant.

The postulation should also contain *all* of the pertinent measurable quantities along with a suggestion of their relative calibration. This is also a logical separation between the quantitative and qualitative phases of the program.

While dimensional analysis can assist with the calibration of the variables to be measured, it does not reveal what variables *must* be measured. Dimensional analysis only hopes that through a probe all of the significant variables have been identified.

It is often pointed out that one can proceed through dimensional analysis when only a partial picture of the system has been obtained.

This is not a virtue.

Partial identification only produces a partial result—which, contrarily, can be much worse than no result at all.

For the scale-up of chemical processes, a relatively small number of mathematically definable chemical and physical processes need to be considered. The basic equations for these processes are known, and if these equations could be solved rigorously the scale-up problem would be essentially nonexistent.

Why the Problem Exists

The scale-up problem does exist, however, for three reasons:

- Many of the important basic equations are unsolvable by known general mathematical techniques.
- The basic phenomena are often interconnected; that is, the basic equations are coupled. The coupling reactions are not always known, may obscure each other and, in any case, compound the mathematical difficulties.
- Necessary physical data required for a solution are frequently unknown and there is some belief that pilot-plant data, particularly in chemical kinetics, are better than bench-scale data.

In the next section of this report, pp. 135 and 136, we have cataloged some of the common thermal proc-

ess operations, along with their equations and comments on the method of solution.

Let's consider now how these equations can be converted to dimensionless form using the equation for conduction and convection heat transfer as an example for a system having no internal heat generation. (This is Eq. X on p. 136.)

The first term in the equation is the rate of net enthalpy change, the second is the rate of change by conduction and the third is the rate of change by convection.

Writing these in dimensional form and dividing the first and last terms by the dimensions of the second term results in a mathematical arrangement that groups the Nusselt and Peclet numbers, thusly:

$$\phi\left(\frac{hD}{k}, \frac{c_p D V \rho}{k}\right) = \text{a constant} \quad (4)$$

Multiplying the numerator and the denominator of the Peclet number by the viscosity, μ, leads to the familiar result:

$$\phi\left(\frac{hD}{k}, \frac{DV\rho}{\mu}, \frac{c_p \mu}{k}\right) = \text{a constant} \quad (5)$$

Solving Postulated Equations

In any given problem that involves differential equations it is also necessary to state the boundary conditions that apply.

These conditions are fixed by the nature of the problem (e. g., zero velocity at the wall in a flowing fluid) and may themselves be nonlinear.

A number of mathematical tools of varying degrees of rigor are available for attacking these equations. For straightforward rigorous solution, it's usually necessary that the equation or equations and initial and boundary conditions be linear. When nonlinear equations of necessity must be substituted into nonlinear equations it's better to change some of the premises or resort to numerical methods.

There is little chance of going far unless some type of convergence is in sight.

A number of methods are available for the solution of second-order partial differential linear equations of this general form:

$$\nabla^2\phi + f = \alpha \frac{\partial^2 \phi}{\partial \theta^2} + \beta \frac{\partial \phi}{\partial \theta} \quad (6)$$

where ϕ is the dependent variable; ∇^2 is the Laplacian operator; f is a function of position; θ = time; and α and β are specified physical constants.

Many of the more important equations encountered in engineering problems can be obtained by specializing the form of Eq. (6). For example, Fourier's equation, Eq. (IX) on p. 136 for constant physical properties is obtained if:

ϕ = t, temperature
$f = G/k$
G = internal heat generation rate
k = thermal conductivity
$\alpha = 0$
$\beta = \rho c_p/k$
ρ = density
c_p = specific heat

Quasilinear problems have also received some attention, resulting in some fairly general techniques.

Separability Required

Many, but not all, of the solution methods require separability; that is, reduction of the partial differential equation to a set of ordinary differential equations.

Your choice of a method of solution depends on the particular form of the equation, system symmetry and nature of the boundary conditions. Representative methods are:

- Series solutions such as: Bessel functions; Legendre polynomials; hypergeometric functions; Fourier series.
- Integral transforms such as: Laplace transforms; Fourier transforms.
- The method of characteristics.
- Conformal mapping.

When You Can't Solve Them

If the original equation or set of equations cannot be solved, several paths are available depending upon the problem and the kind of knowledge desired. Here are seven possible routes that you may follow:

1. Frequently, the problem itself can be simplified without great loss of accuracy and a rigorous solution obtained for the simplified model. An excellent example of this is the reduction of the Navier-Stokes equations by boundary-layer theory.

2. Sometimes the equations can be linearized by judicious approximation, as typified by Oseen's treatment of the Navier-Stokes equations. Often, however, such techniques only slightly extend the applicability of even more reduced forms of the general equations.

3. Almost any system of equations can be solved by numerical analysis, using machines. Specific solutions only are obtained, and the solution for a number of different sets of values may become costly. Monte Carlo methods may be especially useful for problems that involve kinetics and/or diffusion.

4. Analog solutions, either by electric analog computers or more specialized apparatus such as conducting paper, conducting solutions or stretched membranes, can be obtained for a variety of problems especially for those involving transients.

5. Analogy relationships, as between momentum, heat and mass transfer, commend the application of existing data on one system to another.

6. Reduction of the general equations to dimensionless parameters indicates the important groupings of the variables involved and the terms of the equation in which they appear, and aids in the proper application of bench and/or pilot-plant data.

7. Finally, the equations themselves may indicate important features of the solutions, even though the solutions are never obtained. This method requires considerable mathematical insight.

Frequently, two or more of the above techniques can be combined for greater effectiveness. For example, in the core of a hot rectangular metal bar being quenched one might combine an approximate analytical solution near the surface and a numerical calculation. The first illustrative example (p. 137) is of this type.

Attention should be given to the possibility of replacing difficult or nonlinear boundary conditions by more amenable forms. Linear equations with linear boundary conditions possess the property that solutions are additive or "superposable."

It's possible in this way to solve a number of relatively simple problems and combine the solutions into that for a complex problem.

Sometimes it's possible to solve two simple problems whose solutions are known to bracket that of the desired but more complex problem. The second illustrative example (p. 138) is of this form. From this the desired solution may be estimated satisfactorily, or it may be enough to alert you to the bounds of the solution.

Derivative Experimentation

Use of differential equations naturally confronts one with the evaluation of derivatives.

Common procedures too often lead to the measurement of variables which are usually integrals, such as distance, or a weight change, or a time interval rather than the direct measurement of a derivative such as the velocity.

The measured integrals may contribute different relative precisions and include sequential observations even when measured automatically. That is, it may be necessary to measure the flow and temperature changes in a stream at three or more different places. The observations may be simultaneous at the various places but the stream may undergo fluctuation throughout the distance over which points are measured.

This is particularly true of unsteady-state measurements.

Suppose it is desired to measure the average fluid velocity in a conduit. This can be done by allowing fluid to flow into a can over a measured time interval and then measuring the weight or volume of the effluent. These are all integrals.

However, it may be possible to measure the velocity instantaneously through the use of some invariant physical law.

Poiseuille has shown that a proportionality exists between the velocity of the fluid and fluid friction. Suspend an object in the flowing stream and measure the resistance the object affords the flow of fluid.

The frictional force can be transferred to a linear measurement through the displacement of a spring suspending the object and as indicated on a stationary piece of graph paper.

Instrument manufacturers frequently use this procedure — but what does it mean?

Increases Precision

By reading the displacement of the spring one is continuously identifying the term $\partial x/\partial \theta$ when all other influencing variables are held constant.

Even if the device were originally calibrated through the measurement of integral properties it is nevertheless a device for measuring a first-order derivative directly.

Assume next that the rate of flow of the fluid varies such that it continuously increases, decreases or alternately does both. By observing the displacement of the spring on graph paper constantly rotating at right angles to the displacement of the spring, it's then possible to measure the second-order derivative $\partial\ x^2/\partial\ \theta^2$ continuously and instantaneously without the use of integrals.

Many chemical engineering phenomena may be described by first- and second-order differential equations. However, when the final relationship governing a phenomenon is concluded by the integration of measured derivatives, remember that integration is an averaging procedure and that the precision of the final statement is increased.

Conversely, when derivatives are pieced together analytically from the measured responses of integrals, the precision of the statement is reduced in many ways. This is due to such factors as sequential measurement and errors which may be inherent in the integrals, but not necessarily in the derivative.

Chemical reactions furnish an excellent case in which it would be highly desirable to measure a rate directly.

The differential equation governing chemical reaction rate is the well-known mass action law. This states that the rate of reaction is proportional to the active masses of the reactants. Here the characteristic experimental constant is the proportionality constant, which is the specific reaction rate.

If it were possible to measure the reaction rate directly in addition to the active masses, one could obtain the specific reaction rate simply by division. Because of the absence of direct rate-measurement procedures it's usually necessary to measure an integral of the differential equation and the law of mass action to get the total amount reacted as a function of time.

Even worse, many integrals in kinetics have to be measured on the run, so to speak, while they are still changing!

Statistics and Other Methods

After exhausting the possibilities of similarity, a system may remain unresolved because it is still inundated with variables and responses.

In this case one cannot tell what to reject because many responses are affected by a single change in each of many variables. When this occurs the design of the experiment should be changed.

There still remain the enormous, relatively untapped potentialities of statistical analysis and factorial or partial factorial designs.

These allow the development of a *figure of merit* and multidimensional surfaces having maxima and minima which can be followed in the same sense as a mechanism.

In my experience this latter method has proved most effective in the resolution of regimes which are characterized by a great number of variables and a large number of tests and responses. Such an approach can even be applied successfully to the formulation of paints, synthetic rubber compounds, printing inks and innumerable other compounded chemical products.

It elevates formulation to the status of a science.

Also significant is the combination of one or more methods such as: empirics and mathematical analysis; empirics and statistical analysis for the resolution of different responses; or the combination of mathematical analysis and statistical analysis.

The last grouping appears to be the great void in modern experimental technology, although Fick's law represents a first approach.

Perhaps, the presence of the digital computer will prove to be the greatest experimental tool devised so far.

The Proof Follows

This then, is the case for the adoption of a speculative approach to process design and scale-up. So far we have relied on engineering theory and mathematical verification to illustrate our viewpoint.

In the space that remains, we'd like to acquaint you with four of many proven situations where by the postulation of a mechanism (and some of them fairly meek ones at that) all of the needed design equations were solved by derivation. And all of the end applications worked in excellent agreement with the original speculation.

On the facing page, and the overleaf, the illustrative examples are preceded with some information about key mechanisms that will greatly aid in the understanding of the proofs that follow.

General Process Equations and How to Solve Them

Material Balance

Equation—First law of thermodynamics or the conservation of mass.
Comment—Readily solved if all the data are made available.
Generally the material balance for substance i in a given system may be written:

$$\frac{\partial M_i}{\partial t} = \sum_j m_{ij} + \sum_k G_{ik} \qquad \text{Eq. (I)}$$

where

m_{ij} = mass rate of flow of substance i into the system by stream j

G_{ik} = mass rate of generation of substance i in the system by process k

If the substance i is removed from the system by some stream or process, the sign on that term is negative.

Energy Balance

Equation—First law of thermodynamics.
Comment—Readily solved if all data are available.
The general energy equation for several streams may be written this way:

$$\sum_j m_j\left(\frac{u_j^2}{2g_c\alpha_j} + \frac{gz_j}{g_c} + i_j\right) = Q - W \qquad \text{Eq. (II)}$$

where

m_j = mass of stream j
u_j = velocity of stream j
g_c = gravitational constant
g = gravitational acceleration
α_j = kinetic energy correction of stream j
z_j = height of stream j above reference level
i_j = enthalpy of stream j
Q = total heat added to system other than by the streams
W = work done by the system other than on the streams

Phase Equilibrium

Equation—Second law of thermodynamics.
Comment—Readily solved if all data are available.
For an equilibrium system in which pressure is the only force acting:

$$dF = -S\,dT + V\,dp \qquad \text{Eq. (IIIa)}$$

where

F = total Gibbs free energy of the system
S = total entropy of the system
V = total volume of the system
T = temperature of the system
p = pressure of the system

If the chemical potential of species i, μ_i, is defined in the following way:

$$\mu_i = \left(\partial F/\partial N_i\right)_{p,\ T,\ N_1 \ldots N_n} \qquad \text{Eq. (IIIb)}$$

where

N_i = Moles of i

Then, equilibrium exists when:

$$\mu_1' = \mu_1'' = \cdots = \mu_1^{\pi}$$
$$\mu_2' = \mu_2'' = \cdots = \mu_2^{\pi}$$
$$\cdots \quad \cdots$$
$$\mu_N' = \mu_N'' = \cdots = \mu_N^{\pi}$$

where the superscripts distinguish between the various phases.

Chemical Reaction Equilibrium

Equation—The second law of thermodynamics.
Comment—Readily solved if sufficient data are available.
For the general chemical reaction:

$$aR_1 + bR_2 + \cdots \rightleftarrows xP_1 + yP_2 + \cdots \qquad \text{Eq. (IVa)}$$

where a, b, . . . and x, y, . . . are the stoichiometric coefficients of the reactants R_1, R_2, . . . and products P_1, P_2, . . . , respectively, the equilibrium equation is:

$$\frac{(\alpha_{P1})^x(\alpha_{P2})^y}{(\alpha_{R1})^a(\alpha_{R2})^b} = K_a = e^{-x} \qquad \text{Eq. (IVb)}$$

in which $x = \Delta F^\circ/RT$

where

α = activity of the reactant or product in question
K_a = equilibrium constant, a function of temperature
ΔF° = standard free energy change of the reaction
R = gas constant
T = absolute temperature

Chemical Reaction Rate

Equation—Law of mass action.
Comment—Mechanism frequently unknown. Often insufficient data. Equations often solvable.
The rate of a chemical reaction is given by the law of mass action. For the general reaction

$$aR_1 + bR_2 + \cdots \rightarrow Products \qquad \text{Eq. (Va)}$$

the rate of the reaction is given by:

$$-dC_R/d\theta = kC_{R1}{}^aC_{R2}{}^b \qquad \text{Eq. (Vb)}$$

where C_R is the concentration of any reactant; C_{R1}, C_{R2}, . . . , are the concentrations of the respective reactants as functions of time; and k is the reaction rate constant.

Fluid Flow

Equation—The Navier-Stokes equations.
Comment—Second-order, nonlinear, partial differential equations unsolvable in general. Many laminar solutions, very few turbulent.
Obtained by equating the rate of change of momentum of a fluid element to the sum of forces acting on the element.

$$\rho\frac{Du}{D\theta} = F_x - \frac{\partial p}{\partial x} + \frac{\partial}{\partial x}\left\{u\left[2\frac{\partial u}{\partial x} - \frac{2}{3}\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}\right)\right]\right\} + \frac{\partial}{\partial y}\left[u\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)\right] + \frac{\partial}{\partial z}\left[u\left(\frac{\partial w}{\partial x} + \frac{\partial u}{\partial z}\right)\right] \qquad \text{Eq. (VIa)}$$

General Process Equations and How to Solve Them, continued

plus two equations obtained by cyclic permutation of (x,y,z) and (u,v,w) plus the equation of continuity.

$$\frac{\partial \rho}{\partial \theta} + \frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z} = 0 \qquad \text{Eq. (VIb)}$$

where

$$\frac{D}{D\theta} = \frac{\partial}{\partial \theta} + u\frac{\partial}{\partial x} + v\frac{\partial}{\partial y} + w\frac{\partial}{dz}$$

is the particle or substantitive derivative; and where

p = pressure
x,y,z = orthoganol (Cartesian) coordinates
u,v,w = velocities in the x,y,z directions, respectively
ρ = density
μ = viscosity
F_x = gravitational force

Mass Transfer-Molecular Diffusion

Equation—Fick's law.

Comment—Second-order, nonlinear, partial differential equation unsolvable in general, but many important restricted cases have been solved.

This case is controlled by the general form of Fick's law:

$$\frac{\partial C_i}{\partial \theta} = \frac{\partial}{\partial x}\left(D_i \frac{\partial C_i}{\partial x}\right) + \frac{\partial}{\partial y}\left(D_i \frac{\partial C_i}{\partial y}\right) + \frac{\partial}{dz}\left(D_i \frac{\partial C_i}{\partial z}\right) + G_i \qquad \text{Eq. (VII)}$$

where

C_i = concentration of component i
D_i = diffusion coefficient for component i
G_i = generation rate (as a result of a chemica process) of component i

Mass Transfer-Convection-Diffusion

Equation—Modified Fick's law plus the Navier-Stokes equations.

Comment—Second-order, nonlinear, partial differential equations unsolvable in general.

For this case it is necessary to modify Fick's law to allow for convective transport, giving:

$$\frac{\partial C_i}{\partial \theta} = \frac{\partial}{\partial x}\left(D_i \frac{\partial C_i}{\partial x}\right) + \frac{\partial}{\partial y}\left(D_i \frac{\partial C_i}{\partial y}\right) + \frac{\partial}{\partial z}\left(D_i \frac{\partial C_i}{\partial z}\right) - \left(u\frac{\partial C_i}{\partial x} + v\frac{\partial C_i}{\partial y} + w\frac{\partial C_i}{\partial z}\right) + G_i \qquad \text{Eq. (VIII)}$$

where u, v and w are the instantaneous velocities in the x,y,z directions. These are given by the Navier-Stokes equations. In engineering calculations usually it's more convenient to use time-average velocities and an eddy diffusivity to allow for turbulent diffusion.

Heat Transfer-Conduction

Equation—Fourier's equation.

an eddy diffusivity to allow for turbulent diffusion. equations, unsolvable in general but most restricted cases of common interest have been solved.

The general equation governing this case was first established by Fourier in this form:

$$c_p\rho \frac{\partial t}{\partial \theta} = \frac{\partial}{\partial x}\left(k_x \frac{\partial t}{\partial x}\right) + \frac{\partial}{\partial y}\left(k_y \frac{\partial t}{\partial y}\right) + \frac{\partial}{\partial z}\left(k_z \frac{\partial t}{\partial z}\right) + G \qquad \text{Eq. (IX)}$$

where

c_p = specific heat
ρ = density
t = temperature
k_x,k_y,k_z = thermal conductivities in the x, y, z directions respectively
G = volumetric internal heat generation rate

The similarity between this and the general Fick's law equation is readily seen.

Heat Transfer-Conduction and Convection

Equation—Modified Fourier's equation plus the Navier-Stokes equations.

Comment—Second-order, nonlinear, partial differential equations, unsolvable in general. A few special cases have been solved.

Fourier's equation may be modified to apply to this case, as follows:

$$c_p\rho \frac{\partial t}{\partial \theta} = \left[\frac{\partial}{\partial x}\left(k_x \frac{\partial t}{\partial x}\right) + \frac{\partial}{\partial y}\left(k_y \frac{\partial t}{\partial y}\right) + \frac{\partial}{\partial z}\left(k_z \frac{\partial t}{\partial z}\right)\right] - c_p\rho\left(u\frac{\partial t}{\partial x} + v\frac{\partial t}{\partial y} + w\frac{\partial t}{\partial z}\right) + G \qquad \text{Eq. (X)}$$

As in diffusion and convection, u, v and w may be taken as instantaneous velocities obtained from the Navier-Stokes equations, or modified to use time-average velocities and eddy conductivities for turbulent flow.

Heat Transfer-Radiation

Equation—Quantum mechanics.

Comment—Chief difficulty is that interaction between matter and radiation is not well understood on the practical level.

The basic equations of radiation from black bodies are due to Stefan and Boltzmann:

$$E_b = \sigma T^4 = \int_0^\infty E_{\lambda b}\, d\lambda \qquad \text{Eq. (XIa)}$$

and Planck:

$$E_{\lambda b} = C_1 \lambda^{-5}/(e^x - 1) \qquad \text{Eq. (XIb)}$$

where

$x = C_2/\lambda T$

and where

E_b = total energy radiation rate per unit area of a black body
$E_{\lambda b}$ = energy radiation rate of wavelength λ per unit area of a black body
g = Stefan-Boltzmann constant
T = absolute temperature
λ = wavelength of radiation
C_1, C_2 = quantum radiation constants

For real materials, corrections must be made for the fact that black body behavior is not followed. When two or more surfaces are present, the calculation of net transport is usually tedious.

Four Case Studies Describe Successful Applications

Here are some examples of speculative process design in action.

They've been chosen to illustrate cases where the speculative approach has provided substantial reduction in research for scale-up, or its total elimination.

To conserve space, the examples discussed here cover single components and are fairly narrow in scope.

However, the industrial counterparts of these components have been designed and constructed many times. Naturally, we will not be able to document the actual performances for proprietary reasons.

The important point is that through the postulation of a mechanism all of the design equations were definable by derivation and all of the end applications worked in excellent agreement with the speculation.

Case Study One

Object—Expand the generality of a nontheoretical equation.

Application—Chilling by means of scraped surfaces.

The scraped-surface, double-pipe exchanger shown in Fig. 1 is used for dewaxing chilled petroleum fractions and for sensible heat transfer to other viscous fluids. The inner pipe is equipped with a rotor having blades that bear against the pipe.

These blades displace the fluid at its surface by a scraping action. Sensible heat transfer through the exchanger could occur by conduction, if laminar flow prevails; or by turbulence and convection with some transition between the two.

Assuming convection, Skelland[7] obtained an equation through dimensional analysis which he evaluated as follows:

$$hD/k = 4.9(DV\rho/\mu)^{0.57}(c_p\mu/k)^{0.47} \times (DN/V)^{0.17}(D/L)^{0.37} \quad (7)$$

where D is the diameter of the inner pipe; N is the rotation in rpm.; while V is the axial linear velocity.

By using V in the Reynolds number instead of the product (DN) it was necessary to add the term (DN/V) to reconcile axial and rotational velocities. A correlation such as Eq. (7) must of necessity have a limited range of applicability. In fact, it could be misapplied in the prescence of pure laminar flow.

Consider now a more general postulation[8] to include streamline and turbulent flow in series.

The viscous core of the fluid between scrapers is fundamentally in laminar flow rotationally as well as axially and is represented by a resistance to conduction. The opportunity for turbulence at the leading tip of the scraper is provided by expressing the effect of convection as a thickness of liquid δ.

We define conductive resistance by δ/k, where k is the thermal conductivity. Then, the over-all coefficient contains both resistances.

The differential equation for heat conduction is given as Eq. (IX) on p. 136. In cylindrical coordinates with axial symmetry, it is expressed as follows:

$$\nabla^2 t = \left(\frac{k}{c_p\rho}\right)\left(\frac{1}{r}\right)\frac{\partial}{\partial r}\left(r\frac{\partial t}{\partial r}\right) \quad (8)$$

which solves to:

$$\delta/k = Q/\pi DL\,\Delta t_c = \frac{2k}{(\pi k\theta_s/c_p\rho)}\left[1 - \frac{\pi^{0.5}}{4} - \left(\frac{4k\theta_s}{c_p\rho D^2}\right)^{0.5} - \frac{1}{12}\left(\frac{4k\theta_s}{c_p\rho D^2}\right) + \cdots\right] \quad (9)$$

where θ_s is the time between scrapings; r=the radius; and Δt_c is the temperature difference across the conduction resistance.

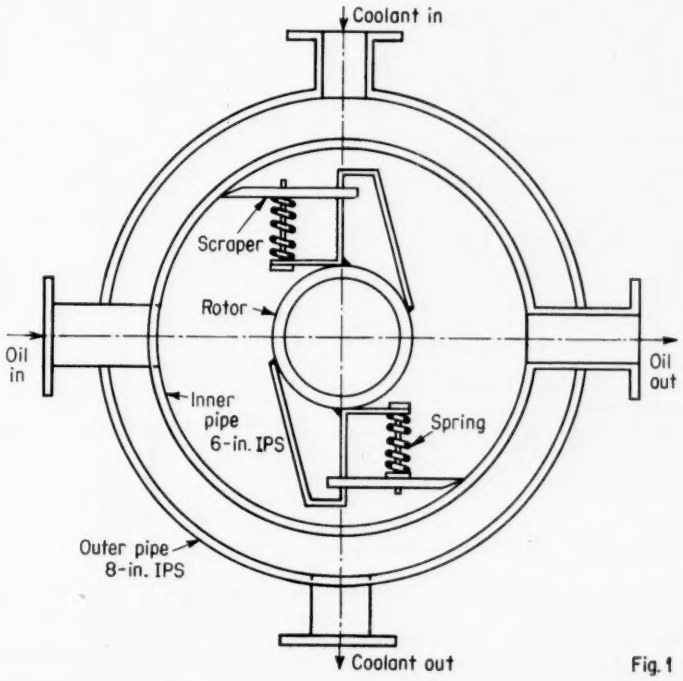


Fig. 1

SCRAPED-SURFACE, DOUBLE-PIPE heat exchanger commonly used for dewaxing chilled petroleum fractions and for sensible heat transfer to other viscous fluids. Inner pipe is equipped with rotor, the blades of which bear against the pipe wall with a scraping action.

If a few runs indicate that δ is small, positive and nearly constant, then the mechanism of laminar flow would be confirmed. If, on the other hand, it shows regular variation with the operating variables, this indicates that convection makes an important contribution to the mechanism.

If it proves erratic, then a discontinuity can be identified. Perhaps there is a transition from predominantly streamline to predominantly turbulent flow. But all possibilities are included.

Case Study Two

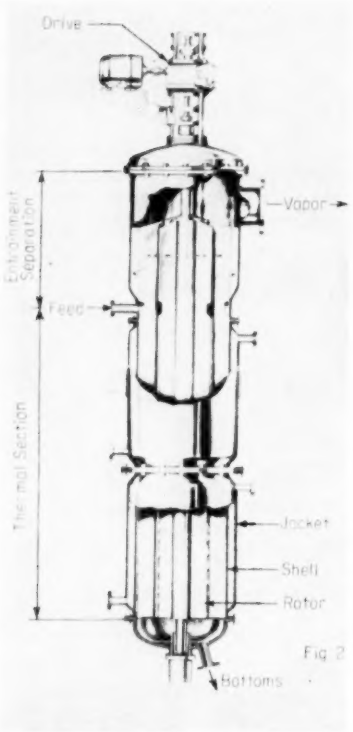
Object—Identification of a mechanism in order to develop a satisfactory probe.

Application—Thermal processing with agitated thin films.

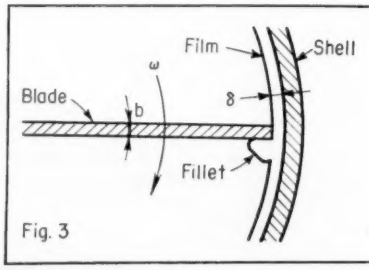
A thin-film processor, as shown in Fig. 2, is used for simultaneous heat and mass transfer involving temperature-sensitive fluids. Here a clearance δ is objectively maintained between the rotor blade and the shell. Feed enters below the entrainment separator and descends by gravity flow. Fig. 3 is a view through the thermal section of the processor.

It has been shown[9] that the descending fluid, as a result of centrifugal force, can only reside at the clearance δ and as a fillet on the lead side of the blade. Since the fluids may be non-Newtonian, and since it is also possible to have some phase change, the fillet can have any of the profiles shown in Fig. 4 as it descends.

The dashed lines indicate defective fillets, i. e., ones which by virtue of quantity or viscosity do not respond to the rotor. Hence they represent a discontinuity of mechanism.

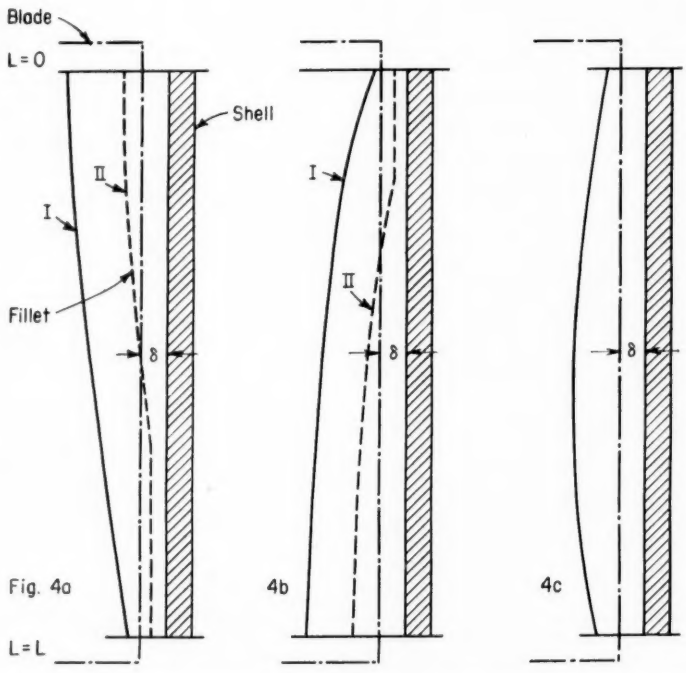


THIN-FILM PROCESSOR used for simultaneous heat and mass transfer involving temperature sensitive and/or very viscous fluids.



Falling Film Yields to Key Mechanism Analysis

View through the thermal section, Fig. 3, shows that the descending fluid can only reside at the clearance, delta, and as a fillet on the lead side of the blade. Fig. 4a shows a decreasing fillet: I is normal; II is deficient. An increasing fillet is shown in Fig. 4b: I is normal; II is deficient. Fig. 4c shows the maximum possible fillet between L = O and L = L.



Articles and sales literature have suggested that the device operates independently or dependently of temperature difference, surface, viscosity, etc. Therefore, they said, the process could not be defined by equations. Manufacturers recommended that each fluid and process change be run in a laboratory model and then be "scaled-up."

Since there were no relationships for scale-up, such as the influence of an increase in feed on an increase in diameter and/or height, scale-up was really reduced to a guess.

Erratic results—both in the literature and on surveying some prototypes which were "scaled-up" from the model—suggested the possible disappearance of the fillet in some cases. A viscous fluid in the small clearance between blade and wall will almost invariably be in laminar flow despite rotational and gravitational effects.

The fillet is different. It only exists when all of the fluid is unable to descend in the clearance between blade and shell. The object is to assure the presence of a fillet, since it produces the principal element of turbulence when the phase change is very small or does not occur at all. Its presence also assures that veinlike flow will not develop near the bottom of the processor. This could invalidate the contribution of the heat-transfer surface.

We can get the wall flow velocity by solving Eq. (VIa):

$$\partial^2 z^*/\partial r^2 = -\rho g/\mu \quad (10)$$

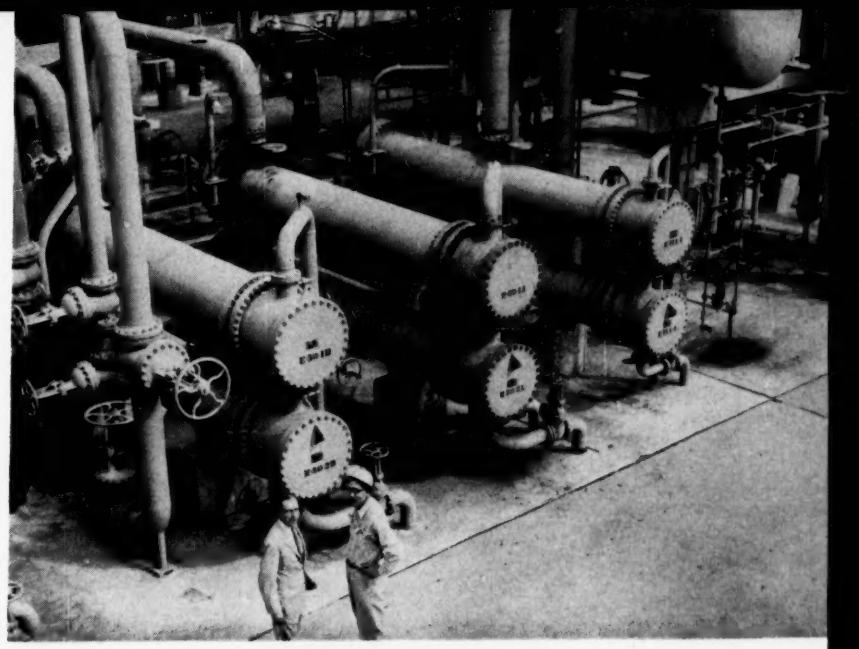
and for the fillet,

$$(\partial^2 z^*/\partial x^2) + (\partial^2 z^*/\partial y^2) = -\rho g/\mu \quad (11)$$

where z^* is the vertical velocity component.

To determine whether there is fluid in the fillet for a given feed rate, diameter and clearance, it's necessary to find the holdup at every point. The fillet must have a cross-section at every point to represent the disposition of the fluid from point-to-point. But its shape is complex and subject to an unusual group of forces.

Let's refer again to Fig. 3 and note the possibility that a triangle might approximate the shape of the fillet. Stoke's theorem states that the flow in an open channel having a planar free surface is identical with that in a closed channel whose walls consist of the walls of the channel and their mirror images projected through the free liquid surface.



DESIGNED TO RUN without shutdowns for cleaning.

Thus, the volumetric flow rate for a square vertical channel has been shown by Boussinesq to be:

$$V' = K_1 \frac{\rho g}{\mu} X^2 \quad (12)$$

where K_1 is a constant (0.14) and X is the cross-section of the square. According to Stokes the right-hand term is then divided by 2.

If there are n fillets, the holdup H is:

$$H = 2\pi RL\delta + nLX \quad (13)$$

where R is the radius of the processor and L its length. The cross-section of the fillet is:

$$X = 3.8n^{-0.5}\left[\frac{\mu V'}{\rho g} - \frac{2\pi R\delta^3}{3}\right]^{0.5} \quad (14)$$

When the right-hand term in the brackets equals or exceeds the left, there is no fillet and the fluid undergoes no rotation. Since these are usually viscous, heat-sensitive fluids the holdup itself is important.

$$H = \int_0^L (2\pi R\delta + nX)dL \quad (15)$$

$$H = 2\pi R\delta L + 3.8n^{0.5}\int_0^L \left(\frac{\mu V'}{\rho g} - \tfrac{2}{3}\pi R\delta^3\right)dz$$

Eq. (15) can in turn be related to temperature, composition and change in properties with both and is readily amenable to computer solution. However, heat transfer and diffusion effects can now be restricted to conditions which pass the test of wetting the entire surface or computing the fraction wetted.

Case Study Three

Object—Development of a mechanism for data already published.

Application — Designing thermal surfaces to run indefinitely.

It's a fairly simple matter to allow for the accumulation of dirt in a pipe by increasing its diameter. If the surface of a pipe is also used for heat transfer, though, it usually takes but a small amount of accumulated dirt to render the surface unusable.

Consider the case where the resistance to heat transfer R_θ is proportional to the thickness of the dirt x_θ at time θ. The resistance at a given liquid velocity has been measured as shown in Fig. 5.[10, 11] When the fouling fluid circulates at greater velocity the heights of the curves are suppressed.

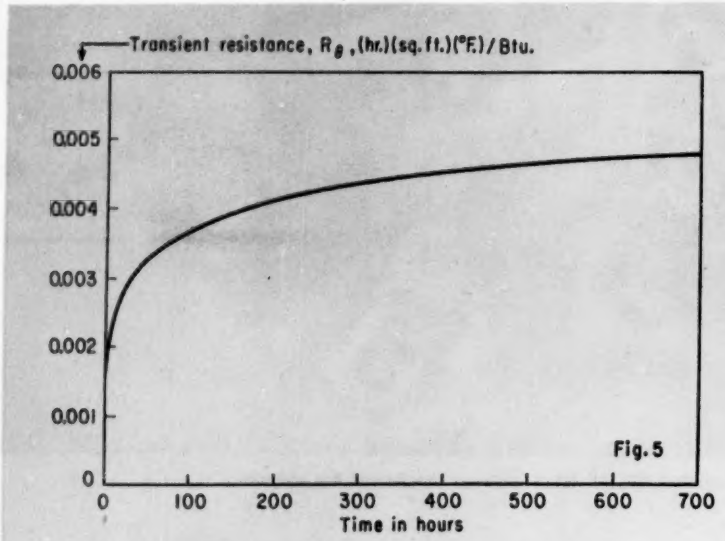
What is the connection between fluid velocity and fouling resistance?

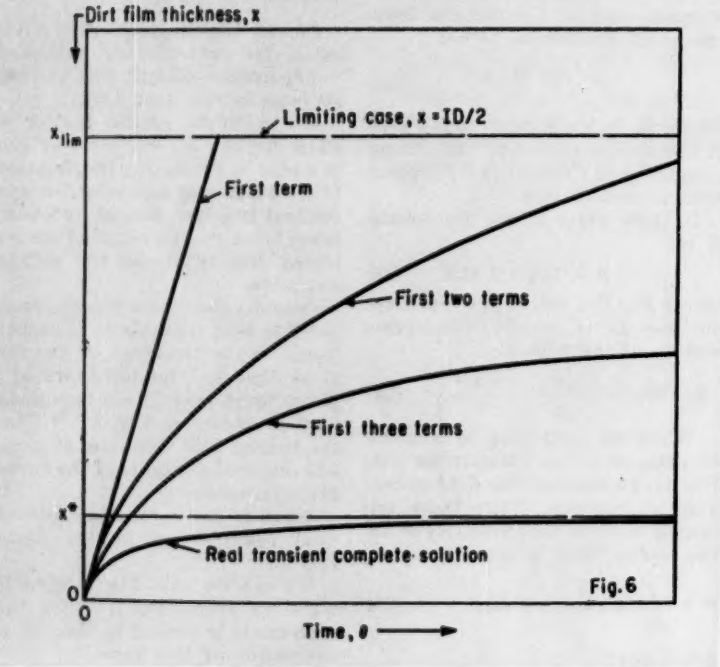
We can see that Fig. 5 aims toward an asymptote R^* such that each curve is related to time by an expression of this form:

$$R_\theta = R^*(1 - e^{-B\theta})$$

where B is an arbitrary constant. Little is known about the mechanism of dirt accumulation; but this really isn't important.

With the methods we have available today, it's not possible to universally eliminate dirt completely and economically from most process streams. So we might as well accept for the present the necessity of ac-





commodating it in thermal design. Fig. 5 tells us what it looks like.

If velocity reduces accumulation of dirt it's probably because of the shear stress exerted by the fluid at the wall. Assume that accumulation is the net difference between dirt deposition and dirt removal. With little else to go on relative to the deposition of occasional dirt particles on a surface, assume it to be directly proportional to the concentration of dirt c' in a constant-weight flowstream, W. Consider dirt removal to be proportional to the shear stress τ.

Then the growth in dirt thickness with time is given by:

$$dx_\theta/d\theta = K_1c'W - K_2\tau x_\theta \qquad (16)$$

where K_1 and K_2 are constants. Integration of Eq. (16) produces the sequence of terms shown graphically in Fig. 6.

Fig. 6 closely approximates Fig. 5. But it yields something more. Since the variables are expressed in terms of the fluid velocity, it's possible to determine the pressure drop needed to suppress the dirt to a permanently tolerable level.

This knowledge encourages the design of thermal plant facilities that require no cleaning—in theory at least—during their operating lifetime. The thickness of the dirt is expressed by:

$$x_\theta = \frac{K_1c'}{K_2}\left[\frac{W^2L^4\rho g}{(\Delta P)^4}\right]^{0.5} \qquad (17)$$

Therefore, the values to be measured are K_1c'/K_2, which previously were not identified in published experimental data, and which were not known to exist or to be significant prior to assuming a mechanism for the growth of dirt in an exchanger.

By dividing values of x_θ for the same fluid under different operating conditions, even the determination of K_1c'/K_2 can be eliminated. For any other fluid one can guess the starting point, as a ratio of K_1c'/K_2, and let the rest of the equation furnish the direction of variation.

We don't know of any plants designed on this principle that have actually run forever. In fact we don't expect to be around to report it when it happens.

But we do know of one which was designed using this principle and it has chalked up a fantastic operating record.

Case Study Four

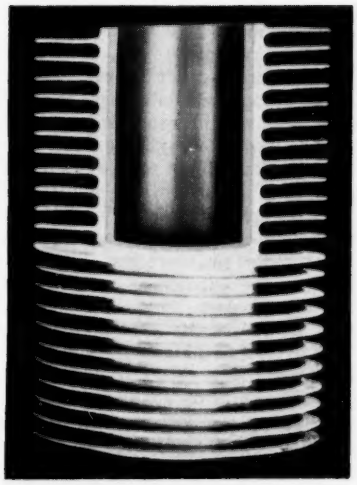
Object—Design on the large scale directly.

Application—Air-fin cooler design.

The air-fin cooler removes high-level heat using atmospheric air and high-fin tubes. It's extremely useful whether or not water is not available.

A forced-draft cooler is shown in Fig. 7. Aluminum high-fin tubing is shown in Fig. 8 (Wolverine Tube). Root diameter is 1.08 in. Fins have an OD of 2.0 in., 9 fins/-in., 0.019-in. thick.

Like forced-draft cooling towers, the hot discharge leaves the heat-transfer surface at low velocity and



HIGH-FIN TUBING fabricated from aluminum—Fig. 8.

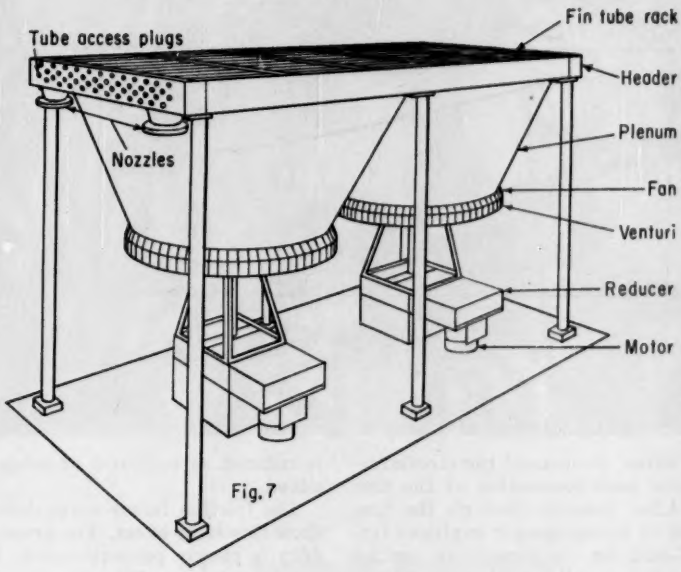


Fig. 7

not very far from the high-velocity air intake. Thus, heated air recirculates with the ambient air, causing a decrease in the effectiveness of the ambient-air temperature. Also, power requirements are increased because of the expanded volume of the hotter recirculating air.

Forced-draft heat transfer and pressure drop data on a commercial scale are shown in the five plotted points on Figs. 9 and 10. The equivalent diameters used are:

$$D_e = \frac{2(\text{total surface})}{\pi(\text{projected perimeter})} \quad (18)$$

$$D_v = \frac{4(\text{net free volume})}{\text{total surface}} \quad (19)$$

What we want to establish is a heat-transfer curve for induced-draft air-fin coolers.

It's known that a sq. ft. of air-fin surface in induced draft is less effective than it is in forced draft. The difference decreases with the number of rows normal to air flow and disappears when the bank of tubes is ten rows deep.

Here's a possible mechanism: The ambient air in forced draft strikes the heat-transfer surface at a high velocity.

In induced draft it reaches the surface at a low velocity and accelerates only after passing between adjoining tubes. Reduced turbulence on the surface facing the air flow reduces the heat transfer per sq. ft. of surface for the first row

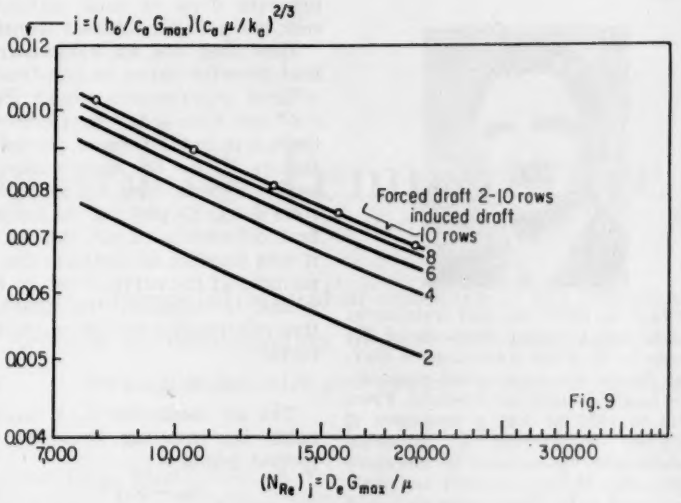
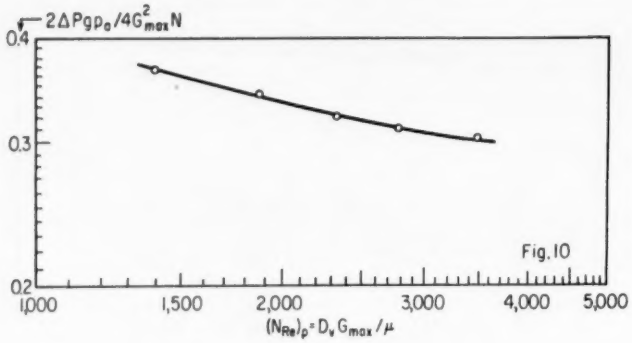


Fig. 9

What Mechanism Rules Air-Cooled Heat Exchange?

Let's start with a typical forced-draft cooler, as shown in Fig. 7, which uses aluminum high-fin tubing, Fig. 8. Commercial data for forced-draft heat transfer and pressure drop are given by the five plotted points shown in Figs. 9 and 10, respectively. Using key-mechanisms analysis can we establish a heat-transfer curve for induced-draft coolers? The answer is yes.

Pressure Drop Data for Large Air Coolers



of tubes, in spite of the circumferential heat conduction of the fins.

After passing through the first row of tubes, the air impinges turbulently on the remaining surface which is usually on triangular pitch. And then, the identity of the heat transfer deficiency of the first row is reduced as each row of tubes is added.

The friction factor curve doesn't show this same effect. The pressure drop is closely proportional to the number of rows. Why?

Well, some minor calculation reveals that the contraction loss on the first row offsets the low approach velocity. Therefore, a first row contributes about as much pressure drop as each additional row, but not as much heat transfer.

How then can an induced-draft heat-transfer curve be constructed without experimental work? Pierson[14] and Kays & Lo[15] have reported their data in the form of correction factors F_N for the mean values of banks N rows deep vs. a bank 10 rows deep. By plotting the ratio of first differences of $\Delta F_N / \Delta N$ vs. N, it was possible to establish the remainder of the curve shown in Fig. 9 and to establish the quantitative relationship for the correction factor:

$$F_N = (1 - e^{-N/3}) \qquad (20)$$

The air coefficient for a ten-row bank, h_{10}, resulting from the five plotted points is:

$$h_{10} = K_1 V^{0.5} \qquad (21)$$

For the remainder of the grid from 2 to 9 rows, let the coefficient be h_N. Then,

$$h_N = K_1 V^{0.5}(1 - 0.5e^{-N/3}) \qquad (22)$$

Quite admittedly this represents the use of bare-tube data for the computation of a fin-tube curve. But is it reliable?

The forced-draft curve represents actual, consistent plant-scale data on five different units and is admissible. If anything, the fin-tube curves will not fan out as much as shown because of the additional friction drag per row. This reduces the ratio of the initial contraction loss to total pressure loss.

Since the uppermost curve represents real data, the lower curves will all be on the safe side. Once one or two air-fin coolers have been designed from this curve, its conservatism can be evaluated for the one or two points and the term $0.5\ e^{-N/3}$ can be adjusted to fit the data.

This will achieve the elimination of experimentation. And the final answer will be established by a safe approach directly on the large scale.

DONALD Q. KERN has had training at M.I.T. and Brooklyn Polytechnic. He heads D. Q. Kern Associates, a thermal design and application organization headquartered in Cleveland. From 1943 to 1953 he was a professor of chemical engineering at Brooklyn Polytechnic, specializing in advanced instruction in heat transfer and thermodynamics. Dr. Kern is the author of the popular text "Process Heat Transfer" (McGraw-Hill). His most recent contribution to the pages of *CE* was a "Remedy for Equipment Fouling: High, Constant Water Velocity," in our Aug. 10, 1959 issue.

ACKNOWLEDGMENT

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Photographs courtesy of those mentioned above; also Humble Oil & Refining Co.; and Burson-Marsteller Associates.

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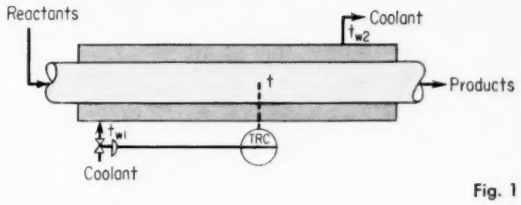


Fig. 1

For Gas-Phase Reactors... Design for Control of Temperature

Successful control of exothermic gas reactions depends on consideration of heat-transfer limitations as well as kinetics and control system dynamics.

FRANCIS G. SHINSKEY, Olin Mathieson Chemical Corp., Niagara Falls, N. Y.

CONTROL of temperature in a chemical reactor, because of its complex nature, is not generally understood in the process industries. It's principally a design problem; a reactor that runs wild on stream can seldom be brought up to expected capacity, even by a skilled and diligent crew.

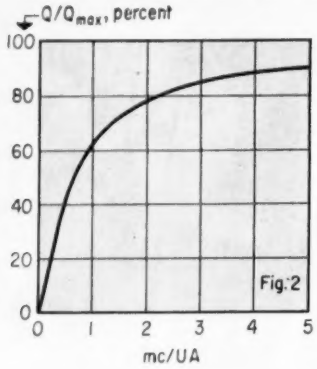
From the many categories of chemical reactions, we have chosen to discuss a continuous, exothermic, gas-phase system, primarily because of the several challenges it presents to the engineer. Our conclusions—based on mathematical analysis of pilot plant studies—provide a guide for design of simple, effective control for an exothermic, gas-phase reactor.

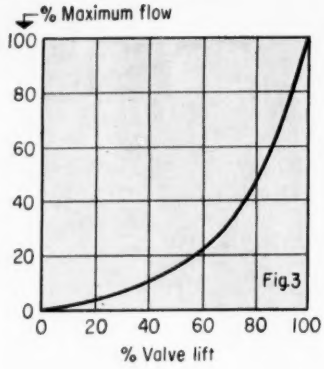
Continuous processes are more common and certainly more demanding than batch reactions. Too, with exothermic reactions, success of a process often depends on close control of temperature to limit side reactions and catalyst deactivation. Finally, because of low heat-transfer coefficients of gas films, distribution of heat effects is more pronounced. The reactor we're discussing is shown in Fig. 1.

Size Heat-Transfer Surface

We wish to conduct a gas-phase reaction at an average temperature t_{avg}. The reaction is exothermic, heat of reaction being H Btu./mole

Choose Equal-Percentage Valve to Linearize the Process





Relate Heat Removal and Coolant Flow

For any finite flow of coolant, the temperature of coolant at the reactor exit t_{w2} is higher than at the inlet. Consequently, the simple expression of Eq. (1) cannot be used for any value of Q less than Q_{max}. The expression for heat transfer now becomes

$$Q = UA\ \Delta t_m \tag{3}$$

where

$$\Delta t_m = \frac{(t_{avg} - t_{w1}) - (t_{avg} - t_{w2})}{\ln\left(\frac{t_{avg} - t_{w1}}{t_{avg} - t_{w2}}\right)} \tag{4}$$

The coolant exit temperature is a function of heat transfer and flow m of coolant of specific heat c.

$$Q = mc(t_{w2} - t_{w1}) \tag{5}$$

Combining equations (3), (4) and (5),

$$mc(t_{w2} - t_{w1}) = \frac{UA[(t_{avg} - t_{w1}) - (t_{avg} - t_{w2})]}{\ln\left(\frac{t_{avg} - t_{w1}}{t_{avg} - t_{w2}}\right)} \tag{6}$$

but $(t_{avg} - t_{w1}) - (t_{avg} - t_{w2}) = t_{w2} - t_{w1}$, therefore

$$mc = \frac{UA}{\ln\left(\frac{t_{avg} - t_{w1}}{t_{avg} - t_{w2}}\right)} \tag{7}$$

$$\frac{UA}{mc} = \ln\left(\frac{t_{avg} - t_{w1}}{t_{avg} - t_{w2}}\right) \tag{8}$$

Solving for $t_{avg} - t_{w2}$, we obtain

$$t_{avg} - t_{w2} = (t_{avg} - t_{w1})e^{-UA/mc} \tag{9}$$

To determine the effect of m upon Q, we must return to Eq. (5),

$$Q = mc(t_{w2} - t_{w1}) = mc[(t_{avg} - t_{w1}) - (t_{avg} - t_{w2})] \tag{10}$$

Substituting for $(t_{avg} - t_{w2})$ from Eq. (9),

$$Q = mc(t_{avg} - t_{w1})(1 - e^{-UA/mc}) \tag{11}$$

Eq. (11) can be rendered dimensionless by dividing both sides by Q_{max}, Eq. (1),

$$\frac{Q}{Q_{max}} = \frac{mc}{UA}\ (1 - e^{-UA/mc}) \tag{12}$$

The solution of Eq. (12) is plotted in Fig. 2 above. Because the reactor has already been designed, from the kinetics standpoint, Q_{max}, U and A are constants, and the curve in Fig. 2 is the relation between Q and m. In its dimensionless form of Q/Q_{max} *vs.* mc/UA, the expression can be used for any reactor, regardless of size and conditions.

of reactant a. Production rate has been established at F_a mole/hr. of reactant a, giving us a normal heat evolution of $HF_a = Q$ Btu./hr.

In the usual design procedure, over-all heat transfer coefficient U can be predicted from a combination of empirical correlations and scale-up data of the pilot or prepilot plant.

Heat produced in excess of process requirement must be removed by coolant in such a way that temperature inside the reactor will be as uniform as possible. Sufficient allowance must be made in the cooling system so that fluctuations in process heat load can be handled without loss of temperature control. Let's set the limits of accurate control at +20% and −50% of normal heat load.

To assure adequate temperature control, we should provide enough heat-transfer area so that normal process heat load requires only 70% of the heat removal capacity of the reactor, i.e., the cooling system normally operates 70% loaded. If we designed the reactor based on 80% heat load, we would save 13% in reactor size and lower the first cost, but it would diminish system ability to handle extra capacity by 33% compared with the 70% normal load design figure.

The maximum rate of heat removal from a reactor of heat-transfer area A with inlet coolant temperature t_{w1} unchanged throughout the jacket is

$$Q_{max} = UA\ (t_{avg} - t_{w1}) \tag{1}$$

This condition corresponds to infinite flow of coolant.

Choosing the 70% normal load discussed above for Q/Q_{max}, the required heat-transfer area is

$$A = \frac{Q_{max}}{U(t_{avg} - t_{w1})} = \frac{Q}{0.7U\ (t_{avg} - t_{w1})} \tag{2}$$

To satisfy requirements of this heat-transfer area, as well as kinetics requirements of reactor volume and linear velocity of reaction mixture, appropriate sizes of pipe are juggled to select reactor configuration.

Heat dissipation must equal heat evolved by the reaction to keep average temperature of the reactor under control. This means that temperature control is really heat-removal control. In practice, the control system is generally the slave of the process load. If the temperature is controlled by heat evolution

Check System Linearity

% Valve Lift	mc/UA	Q/Q_{max}(%)
10	0.08	7
20	0.14	12
30	0.29	28
40	0.42	38
50	0.67	52
60	0.92	61
70	1.30	70
80	1.93	78
90	2.94	85
100	4.20	89

(i.e., process load is slave of the control system), there is only one rate of production that provides the desired temperature. This leads to an undesirable, inflexible control situation.

There are two ways to control heat removal rate: controlling the flow of coolant and controlling coolant inlet temperature. The mathematical derivation in the box on the left provides a generalized solution for flow control.

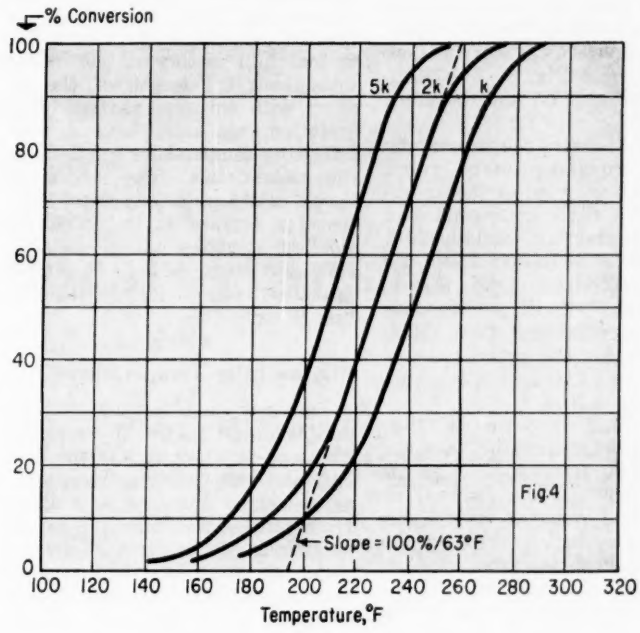
Linearize the Process

The exponential relation of rate of heat removal and mass flow of coolant shown in Eq. 11 introduces nonlinearity into the temperature control system. At low values of m, Q increases rapidly with m, but as Q approaches Q_{max}, the effect of m is small. We should pick a control valve whose characteristics tend to compensate for the process nonlinearity. If an equal-percentage control valve is used to throttle coolant flow, the change in flow per unit change in valve lift is low at low values of lift and high at high values of lift. This is what we need to compensate for behavior of Q with respect to m.

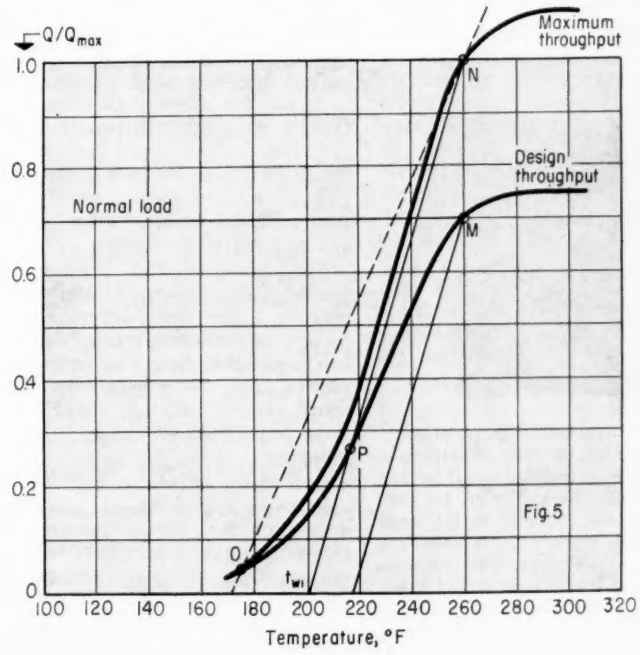
Nomenclature

- A **Heat-transfer surface area.**
- c **Specific heat of coolant.**
- H **Heat of reaction, reactant *a*.**
- F_a **Production rate, reactant *a*.**
- m **Mass flow of coolant.**
- Q **Heat rate.**
- Q_{max} **Maximum heat rate.**
- t_{avg} **Average reactor temperature.**
- t_{w1} **Coolant inlet temperature.**
- t_{w2} **Coolant outlet temperature.**
- Δt_m **Log mean temperature difference.**
- U **Over-all transfer coefficient.**

Conversion Rate Doesn't Change with Residence Time



Maximum Throughput Conversion Fixes Coolant Temperature



Choose Coolant Flow

Having sized the reactor based on a normal load of 70% of capacity, we can select the normal flow of coolant from Fig. 2. At $Q/Q_{max} = 0.7$ $mc/UA = 1.3$ and therefore $m = 1.3UA/c$.

We can linearize the process by using an equal-percentage valve, and now we must select the appropriate valve size. At normal load of 70%, the stem lift would be 70% if the process is linear. From the valve characteristic curve, Fig. 3, we see that 70% lift corresponds to 31% of maximum flow. Maximum flow for the process should therefore be $1.3(UA/c)/0.31$ or approximately $4.2UA/c$.

Using Fig. 2 and 3, we can determine limits of controllability of our process. Taking values of valve lift from 10-100%, and comparing them to heat removed by the corresponding coolant flow, we get the results shown in the table.

From the table, you can see that limits of controllability are 0-89% loaded which fulfills the original requirements. The system is linear within 2% from 30-80% loaded which permits maximum controller gain (minimum proportional band) throughout the range of operation.

Choose Flow Pattern

Concentration of the reactants is highest at the reactor inlet, so we might expect by the laws of kinetics that the reaction rate and its accompanying heat evolution are greatest at the inlet. If we are to maintain isothermal conditions throughout the length of the reactor with this non-uniform heat evolution, we must have a compensating temperature gradient on the coolant side. The largest Δt should exist across the reactor heat-transfer surface at the inlet, the smallest Δt at the outlet. As a result, we must choose co-current (parallel) coolant and reaction mixture flows.

FRANCIS G. SHINSKEY is instrument engineer for all of Olin Mathieson's energy division pilot plants in the Niagara Falls area. Prior to 1957 he was process engineer in the company's high energy fuels research program. He also served on the technical staff of DuPont-operated Savannah River Atomic Energy Works. He holds a B.S.Ch.E. from the University of Notre Dame.

Choose Inlet Temperature

You may have noticed that the only term not defined in the mathematical expressions was the coolant inlet temperature. We can imagine almost any cooling medium, from refrigerated brine to hot oil, as long as it's colder than the reactor operating temperature. But how much colder? A greater temperature difference can remove more heat through a given area, but there's a practical limit.

The limit lies in the reaction kinetics. Chemical reaction is sensitive to temperature change. If cooling water at 60 F. is used for a reactor designed for 200 F., it's doubtful if the reaction will "go."

The under-design coolant temperature causes vicious temperature cycling as coolant is turned on and off. By trial-and-error, of course, we can provide warmer coolant until the right temperature is found for smooth performance. On the other hand, if heat-transfer area was selected for coolant at 60 F., and now we feed coolant at 130 F., heat transfer, and therefore production rate, is limited to one-half design rate.

The curves of Fig. 4 represent performance of a typical first-order reaction under three different conditions of residence time. Curves for many other reactions have been plotted and, in general, are the same shape, varying slightly in slope but displaced widely in temperature.

One of the curves of Fig. 4 also appears in Fig. 5 which plots heat evolved on the ordinate rather than percent conversion. This curve, representing design throughput, intersects $0.7Q_{max}$ at point M, the design temperature and conversion. Curve follows $Q = HF_af(t_{avg})$. The other curve of Fig. 5, representing maximum throughput, intersects Q_{max} at point N. This point is also at design temperature but at somewhat lower conversion because of decreased residence time.

If we draw a straight line from point N, parallel to the maximum throughput curve, it intersects the temperature axis at the lowest acceptable coolant temperature. This line (from Eq. 1) represents heat transferred to the coolant; its slope is UA. We can draw a similar straight line of slope UA through point M for design conditions. Point on the temperature axis where it intersects is the mean coolant temperature; to achieve these conditions coolant must be throttled.

Consider the situation where a colder medium, and therefore a smaller heat-transfer area, is specified. In this case, we draw (for example) the broken line of Fig. 5. The point of intersection at the operating temperature is unstable: if conversion drops below this point, heat is removed faster than it's generated, and the reactor cools to the next lower intersection, point O. The design conversion is an unstable point above a stable point. It is exceedingly difficult, at startup, to move the reaction beyond the stable point O to which it will always return from other operating points should the slightest load upset occur.

In a properly designed reactor, maximum throughput demands full flow of coolant at the design temperature. At normal throughput, the reactor can be cooled at low as the temperature at point P, the intersection of the reaction curve and the maximum cooling line.

Conversion *vs.* temperature data, from which the exact coolant temperature can be obtained, is rarely available in early plant design stages. In order to set some sort of safe limits for design, curves for well-known reactions have been plotted and the maximum slopes measured. These slopes vary from 100%/60° F. to 100%/130° F. For example, the curves of Fig. 4 are for the first-order decomposition of N_2O_5. The maximum slope of these curves is 100%/63° F. We may infer from these figures that a safe Δt for an unknown reaction is 60° F. Coolant temperature should be adjustable to accommodate change in feed composition or inaccuracies in design data.

Rockets, jets, nuclear reactors, oil production with "H" bombs, all these open up new . . .

Frontiers in Heat Transfer

GLENN B. WARREN, President, American Society of Mechanical Engineers

In a post-war appraisal of the technological needs of my own company, we came to the conclusion that our two greatest deficiencies existed in the heat transfer and metallurgical areas. We thought then that these two areas contained more limiting factors on our further technological development than any other, and that furthermore we were more ill-equipped to handle the advancing technological needs in these areas than in others. Accordingly, steps were taken to overcome these shortcomings.

We believed, at that time, that we needed additional information concerning heat transfer in connection with:

- Electrical machine performance, that is, increased and more uniform heat dissipation.
- Power plant machinery (boilers, superheaters, resuperheaters, condensers, feedwater heaters, etc.)
- Cooling of internal combustion machinery.
- Commercial and domestic refrigerators, stoves, air conditioners and so forth.
- Chemical processes in the chemical and petroleum industries.

Most of these needs were characterized by relatively low rates of heat transfer. Only in the evaporative parts of large marine power boilers was there apparently need for fairly high rates of heat transfer.

Rating of electrical machinery, that is, the total output which one can get out of any particular machine, depends to a very great degree upon whether or not the heat loss, which generally increases as the square of the output, can be taken care of through the relatively heat-sensitive electrical insulation material which surrounds the conductors. This factor set a sharply defined limit upon the maximum capability of any specific machine.

Heat transfer technology developed largely along lines designed to meet these needs and continued for several years with rather moderate ambitions and goals.

Within a few years, however, the explosive needs of new technology have demanded considerations of heat transfer requirements that are almost a whole order of magnitude or more in advance of what we have been doing up to this time.

Let us take a look at this newly developing technology and its needs from the standpoint of heat transfer.

New and more scientific ventilation concepts for electrical machinery were developed which, in many cases, permitted a 50 to 100% increase in capability for a given frame size. New insulations were developed which permitted higher temperatures and, hence, increased heat dissipation for any given ventilating system.

Then, we began to apply an old concept of cooling electrical machinery by forcing either gas or liquid through hollow electrical conductors (direct cooling we called it), which eliminated the dam to heat transfer that the electrical insulation itself had always been. This has permitted an additional 2- to almost 4-to-1 increase in the capability from given basic frame sizes for large turbine-generators.

Less spectacular changes in other generators and motors, transformers, switchgear and the like, made possible by better heat transfer techniques and higher temperature differences resulting from these new insulation materials, have permitted a corresponding increase in the rating capabilities of these types of machinery.

In power machinery, single power plant boilers have increased from a maximum of some hundred thousand kilowatts 20 years ago, to 400,000 kw.—and even 500,000 kw.

"We are in a growing and dynamic field of technology which has tremendous potentialities for growth and application to meet the expanding needs of this Age of Science and Engineering.

"Emphasis on the fundamentals must be supplemented by emphasis on the application and design areas of this growing and changing field of technology."

This article is based upon an address delivered at the 1959 ASME-AIChE Heat Transfer Conference and Exhibit held at the University of Connecticut, Storrs, Connecticut, on August 9-12, 1959.

—today. Higher steam pressures and higher steam temperatures have multiplied the problems. The heat of evaporation has had to be put in at about 700 F. and the superheat has had to be transmitted through tubes to steam at temperatures of 1,000 F. to 1,150 F. in plants which are in operation today. Steam pressures have gone from 1,200 psi. of 20 years ago, to 4,500 and 5,000 psi. in some cases today. A standard pressure today is 2,400 psi. and 3,500 psi. will probably be more or less standard in another two years.

Feedwater in these new boilers has to be chemically pure to an unprecedented extent if it is not to form deposits to which the new high-temperature, high heat-transfer boiler tubes are more sensitive. Purity of feedwater is now measured in parts per billion, not parts per million as formerly, and it must be treated with chemicals which leave no solid residue.

GLENN B. WARREN, 1959 President of the ASME, is also Vice-President and Consulting Engineer—Turbine Division, for the General Electric Co. He has a long history of service with both organizations.

A member of ASME since 1924, Mr. Warren has held many posts in the Society, both local and national. He was the first national director to represent the Board on Technology and was named a Fellow in 1946.

Mr. Warren joined General Electric in 1919 immediately following his graduation from the University of Wisconsin and has since advanced through the company in the Turbine Division to his present position. He holds 47 patents, dealing mainly with turbines.

Among his honors are a certificate of commendation from the U. S. Navy, the ASME medal for "leadership in the science and art of turbine design," the G.E. Coffin Award and an honorary D.Sc. degree from Union College.

"The explosive needs of new technology have demanded considerations of heat transfer requirements that are almost a whole order of magnitude or more in advance of what we have been doing up to this time."

The problems we have been talking about, however, become simple in many respects compared to those involved in heat transfer in nuclear power reactors. Although I have few exact figures, I am inclined to believe from what I do know that the heat transfer rates in some of these reactors must be three to five times what they are in the highest-rated fossil fuel boilers to date. Not only are ordinary ferritic and austenitic materials involved, but new and exotic materials must frequently be used because of a whole new scientific concept. This is "neutron economy," a phrase and concept totally unknown a generation ago.

Then, again, if we look at the gas turbine, we find a whole host of new kinds of heat transfer problems. These are turbine wheel cooling, turbine bucket and nozzle cooling, combustion chamber liner cooling, compressor intercooling and regeneration of exhaust heat. This last is the return of exhaust heat to the inlet compressed air on its way to the combustion chambers to save fuel. All of these processes must transfer fantastic quantities of heat, usually from gas to gas, with small temperature and pressure differences, or else the purpose of heat transfer itself is defeated.

In the airplane gas turbine many of these problems become acute. In some cases we are cooling turbine wheels with 700 to 800 F. air. Further, we must cool the lubricating oil by the fuel going to the gas turbine.

We drive these new planes so fast that cooling problems develop in the cockpit. We must develop air conditioning systems light in weight and tremendous in capacity to meet these problems.

With respect to the newest technology, that of the rocket, we must handle oxidizers at many hundred degrees below zero, and combustion temperatures must be measured in the thousands. Gears must be run at fantastic temperatures, speeds and outputs. New lubricants with strange properties must be developed. Light weight and high strength are very important.

The nose cone and its re-entry problems, man-in-space problems, dissipation of heat from satellites, etc., all pose new problems of heat transfer that were never dreamed of a generation ago.

The growth of air conditioning and the heat pump, pose new problems in domestic and commercial heating. Air conditioning of motor cars with low-cost, low-power equipment presents still other problems. The other day I heard talk of the possibility of air conditioning whole towns, although I must confess at the moment that I do not know the details.

There are two new areas of technology that may make new and different demands on the science of heat transfer. I am referring first to the growing awareness of a need for a low-cost means of producing fresh water from salt water. Many processes are under study, but I suspect that the multiple-effect evaporative process will have quite wide application. We need to be able to do the job at lower cost than by any of the present available schemes.

The second has to do with the probable use of H bombs in underground explosions to develop power and drive oil and gas out of lean oil-bearing strata.

What I have tried to say only emphasizes what you already undoubtedly know. We are in a growing and dynamic field of technology which has tremendous potentialities for growth and application to meet the expanding needs of this Age of Science and Engineering. Engineers are doing a fine job in laying the basic foundations to meet these needs.

Emphasis on the fundamentals must be supplemented by emphasis on the application and design areas of this growing and changing field of technology.

Filter designs vary but all involve fluid flow through porous solids to achieve separation of solids from slurries.

CE Refresher

How to Analyze Filtration

JESSE COATES and BERNARD S. PRESSBURG, Louisiana State University, Baton Rouge, La.*

FILTRATION is a special case of fluid flow that involves flow of fluids through porous solids. The purpose of this operation is to separate a solid from a fluid that may be a gas or a liquid. In the most common case, the fluid is a liquid.

Plate-and-frame filter presses, leaf presses, rotary drum filters, centrifugal filters and gravity bed filters are common devices employed for this unit operation. Plate-and-frame filter presses are usually operated under pressure. Leaf presses and rotary drum filters may be operated under pressure or vacuum. In leaf presses, the leaves may be stationary or may be removable from the body of the filter unit. Although many different devices can be used to carry out filtration, the basic rate equation for fluid flow applies to each of these.

$$\text{Rate} = \text{Potential}/\text{Resistance}$$

Rate of filtration may be expressed as volumetric flow per unit time, or as a weight of fluid passing through the filter per unit time. Volumetric rates are more commonly used and, consequently, are used in this article. Since many of the filters operate batchwise, the rate frequently varies with time. Thus, we can express the basic rate equation in differential form.

$$\text{Filtration rate} = dV/d\theta \qquad (1)$$

Here, V is the volume of filtrate in convenient units such as cu. ft. and θ is time in sec.

Types of Motivating Potential

In filtration the motivating potential is mechanical. It may be expressed as a difference in pressure, or as a gravitational force, or as the ratio of centrifugal or similar force acting on the slurry to the normal gravitational force. Pressure difference is most commonly used, particularly in such devices as plate-and-frame filter presses, leaf presses and rotary drum presses.

Potentials expressed as gravitational forces are employed in filter beds of the percolating type. Potentials in terms of gravitational ratios are commonly used in centrifugal filters. Each of the latter potentials may be converted to an equivalent pressure difference.

Pressure drop in the filter consists of the pressure drop occurring across the cake plus that occurring across the cloth plus that occurring in the channels of a filter press or device. In our analysis, pressure drops occurring in the inlet channels of the filtration device are neglected. Consequently we will be concerned with the total pressure drop occurring across the cake and cloth only.

* To meet your authors, see *Chem. Eng.*, May 18, 1959, p. 182.

How to Evaluate Flow Resistance

Rate of flow of filtrate that results from a given potential depends on the total resistance. This total resistance is the sum of the resistances offered by the filter cake and by the filter medium.

$$R = R_c + R'$$

where R is total resistance, R_c is resistance of cake and R' is resistance of cloth or filter medium.

We will use the term filter medium synonymously with the term filter cloth. Actually, the medium may be of cloth, porous wire, ceramic or any other suitable material.

Resistance of the cake depends on the viscosity of the fluid flowing through the filter cake μ, thickness of the cake L, permeability of the cake K, and area available for filtration normal to the direction of flow of the filtrate A. The following equation gives the relation of these variables:

$$R_c = \mu L/KA \qquad (2)$$

Permeability is a property of the cake. Quantitatively, it is defined as the rate of flow of a fluid of unit viscosity across a unit area through a unit thickness and under a unit pressure drop. Its value is determined by characteristics of the cake such as porosity, specific surface and compressibility. These and their relationship to the permeability will be discussed later.

Thickness of the filter cake is proportional to the volume of filtrate, or the weight of filtrate which has passed through the unit. To calculate the thickness from the volume, it is necessary to know the density of the filtrate and the concentration of solids in the slurry. The relationship of these quantities is expressed by:

$$L = s\rho V/A\rho_c(1 - sm) \qquad (3$$

where L is cake thickness, ft.; ρ is density of filtrate, lb./cu.ft.; ρ_c is density of dry washed cake, lb./cu.ft.; m is weight ratio of washed wet cake to dry cake; and s is weight fraction insoluble solids in the slurry.

Substituting the value of L from Eq. (3) into Eq. (2) gives the resistance of the cake as:

$$R_c = \frac{s\mu\rho V}{KA^2\rho_c(1 - ms)} \qquad (4)$$

Since all the solids in the slurry end up in the cake, a material balance shows that:

$$M_c = Vs\rho/(1 - ms) \qquad (5)$$

where M_c is the weight of the cake in lb. corresponding to the volume of filtrate V. Using this relation, we may write Eq. (5) as:

$$R_c = \frac{\mu M_c}{KA^2\rho_c}$$

Rather than use the permeability K, it is preferable to use a specific cake resistance α which is defined as follows:

$$R_c = \frac{\alpha\mu M_c}{g_c A^2} = \frac{\alpha\mu s\rho V}{g_c A^2(1 - ms)} \qquad (6)$$

Here, g_c is gravitational conversion constant and equals 32.2 ft./sec.[3] Specific cake resistance is the resistance offered to a fluid of unit viscosity by a unit weight of cake laid down on a unit area of cloth. By equating Eqs. (4) and (6), we get the relation between permeability and the specific cake resistance.

$$K = g_c/\alpha\rho_c \qquad (7)$$

Density of the cake ρ_c may be related to the porosity of the cake by:

$$\rho_c = (1 - \epsilon)\rho_p \qquad (8)$$

Where ρ_p is density of particles of the cake, lb./cu.ft. and ϵ is porosity, volume of voids/volume of cake. Thus, we can write Eq. (7) in another form to express cake porosity.

$$K = \frac{g_c}{\alpha\rho_p(1 - \epsilon)} \qquad (9)$$

Consider Properties of Cake Structure

In the previous relations, we assumed that flow through the passages in the cake is laminar. With this assumption, we may modify the Kozeny-Carman equation to apply to filtration.

$$\frac{dp}{dL} = \frac{k\mu\alpha(1 - \epsilon)^2(S_p/V_p)^2}{g_c\epsilon^3} \qquad (10)$$

Hydraulic mean radius R_H for flow through porous beds may be expressed in terms of the porosity of the bed ϵ and the ratio of the surface area of an individual particle to the volume of the particle S_p/V_p.

$$R_H = \frac{\epsilon}{(1 - \epsilon)(S_p/V_p)} \qquad (11)$$

Using this term for the hydraulic mean radius, we may show that the cake permeability is:

$$K = \frac{g_c\epsilon^3}{k(S_p/V_p)^2(1 - \epsilon)^2} \qquad (12)$$

where k is a constant characteristic of the cake. We may also show that specific cake resistance is:

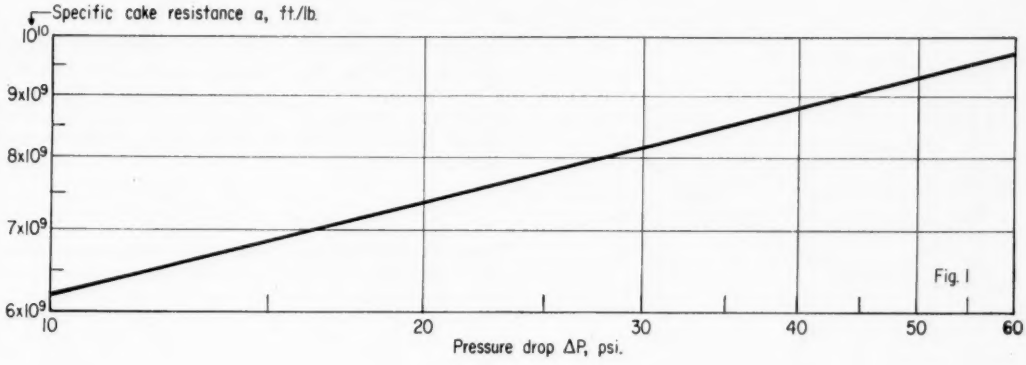
$$\alpha = \frac{k(S_p/V_p)^2(1 - \epsilon)}{\rho_p\epsilon^3} \qquad (13)$$

Note that Eqs. (12) and (13) show the effects of the cake structure on the cake resistance. However, these equations are directly useful only for beds of rigid particles in which the porosity and the surface to volume ratio of the particles is unaffected by the pressure drop across the cake. Cakes of this type are called incompressible.

For incompressible cakes, the specific cake resistance can be directly calculated for particles of a known geometric shape and having a uniform size. In some cases, the cake is incompressible but the geometry of the particles and the size distribution is unknown. The important thing to note is that these factors remain constant for incompressible cakes.

Few cakes are completely incompressible. In the general case, the porosity and shape of the particle are affected by the pressure applied on the particle. For example, spherical particles can assume an ellipsoidal shape under the influence of pressure. Such changes in the shape of elastic particles affect its surface to volume ratio. For these reasons both the permeability K and the specific cake resistance α are affected by pressure. It is important to note that the value of α in Eq. (6) is the average specific cake resistance for the cake which has been formed by the deposition of M_c pounds of solids on the cloth.

Determine Specific Cake Resistance From Experimental Data



Pressure Affects Cake Resistance

For compressible cakes, there is no way to predict α without experimental data. Consequently, experiments are usually conducted in which α is determined at various pressures. A plot is then made of α vs. ΔP. A typical plot of such data is shown in Fig. 1.

To minimize the amount of experimental data, it is often assumed that α varies exponentially with ΔP. Hence, a plot of α vs. ΔP on log-log paper would be a straight line. If we make this assumption, the following relation gives α:

$$\alpha = C(\Delta P)^n \qquad (14)$$

Theoretically, only two determinations are necessary to evaluate the constant C and the exponent n. However, a sounder procedure is to obtain sufficient experimental data so that a definitive plot of α vs. ΔP can be made. Then refer to this plot to obtain values of α for use in Eq. (6).

Since size distribution and shape of the particles in a slurry sometimes vary with its age and method of preparation, experimental checks are often necessary to determine these effects on α.

Cake resistance as defined by Eq. (6) consists of two items:

1. Resistance caused by weight of the cake. This is the product of α and M_c.
2. Resistance caused by the properties of the filtrate and the dimensions of the filtration device. This is the term $(\mu/g_c A^2)$.

Thus, the over-all cake resistance is given by:

$$R_c = \alpha M_c(\mu/g_c A^2)$$

Cloth Resistance Has Minor Effect

Shortly after the filtration process starts, the pores of the cloth become partially plugged with particles from the slurry. This plugged cloth is the real filter medium rather than the open cloth. Hence, there is no way except by experience or experiment to predict the total cloth resistance R'. Experimentally, it is easy to determine the total resistance R from Eq. (1). Cloth resistance is then obtained by difference, $R'=R-R_c$. We can evaluate R_c by methods previously described. Procedures for the determination of R' by experimental methods will be discussed later.

Cloth resistance appears to depend on the pressure drop, on the nature of the slurry being filtered, and on the age of the cloth. Although cloth resistance varies with the pressure drop across the cloth, it is usually sufficiently accurate to treat the cloth resistance as a constant since it is obtained experimentally as an average value. Except for some continuous filters, cloth resistance usually proves to be a small fraction of the total resistance.

It is sometimes convenient to express the cloth resistance in terms of an equivalent cake resistance. At the start of the filtration the total resistance lies in the cloth. Designating initial conditions by the subscript zero, Eq. (1) becomes:

$$\left(\frac{dV}{d\theta}\right)_o = \frac{\Delta P_o}{R'}$$

If R_c' is defined as the resistance of the layer of cake which would offer the same resistance as that of the cloth, then $dV/d\theta = \Delta P_o/R_c'$ or

$$R_c' = R' = \alpha M_c'\left(\frac{\mu}{g_c A^2}\right) = \frac{\mu V' \rho}{K\rho_c(1 - ms)A^2} \qquad (16)$$

Here M_c' is the weight of the solids in the cake which offers the same resistance as the cloth and V' is the volume of filtrate required to deposit M_c' pounds of solids on the cloth.

Both M_c' and V' are imaginary quantities which are used for the sole purpose of putting the expression for the cloth resistance in the same mathematical form as that for the cake resistance. This is entirely a matter of convenience. It is not necessary that this be done and it sometimes leads to confusion.

How to Use the Basic Equation

We may put Eq. (1) in the following form:

$$\frac{d\theta}{dV} = \frac{R}{\Delta P} = \frac{R_c}{\Delta P} + \frac{R'}{\Delta P} \qquad (17)$$

Find Time by Graphical Integration

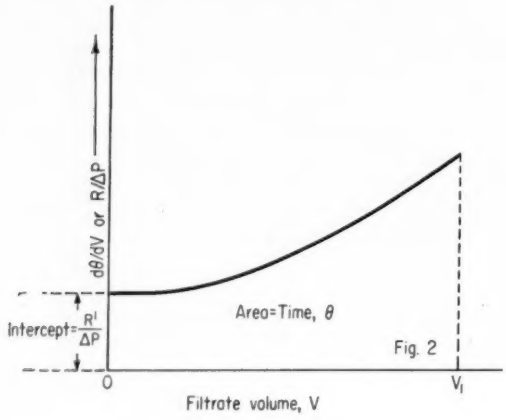


Fig. 2

Find Instantaneous Filtration Rate

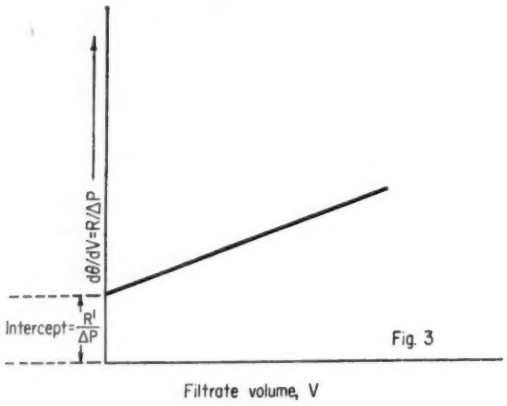


Fig. 3

Plot Eq. (21) For Total Filtration Time

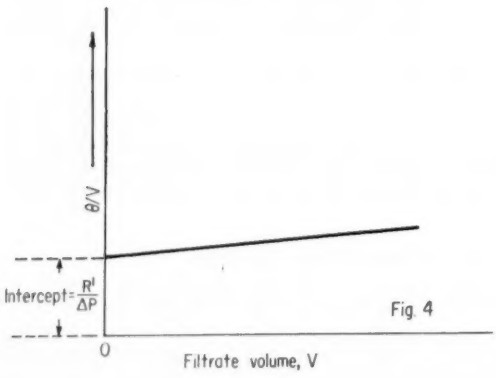


Fig. 4

If we rearrange Eq. (17) to solve for time, we get

$$\theta = \int_{V=0}^{V=V_1} \frac{R\,dV}{\Delta P} \tag{18}$$

Evaluate the integral from experimental or calculated data by plotting $R/\Delta P$ against V as shown in Fig. 2. The area under such a plot represents the time required for filtration. Intercept at $V=0$ *is equal to* $R'/\Delta P$. At any other value of V, the resistance of the cake is

$$\frac{R_c}{\Delta P} = \frac{R}{\Delta P} - \frac{R'}{\Delta P}$$

From this equation and Eq. (6), the average value of the specific cake resistance may be obtained.

A plot, such as that shown in Fig. 2, is a very convenient way to use experimental data to resolve the total resistance into its component parts. Once this has been done, values of R_c and R' for conditions other than those employed in the experiment can be computed. A few values of the total resistance should suffice to construct a similar plot for the new conditions.

Constant Pressure Filtration

Since the cake resistance is substantially independent, constant pressure filtration data frequently give a straight line when plotted in the manner shown in Fig. 3. For a straight line plot, the time is readily found:

$$\theta = \frac{(R + R')V}{2\Delta P} \tag{19}$$

Rearranging Eq. (19) and using the relation $R = R_c + R'$ gives:

$$\frac{\theta}{V} = \frac{R_c}{2\Delta P} + \frac{R'}{\Delta P} \tag{20}$$

Substituting Eq. (6) for R_c yields:

$$\frac{\theta}{V} = \frac{\alpha\mu s\rho V}{2g_c A^2(1 - ms)\,\Delta P} + \frac{R'}{\Delta P} \tag{21}$$

This is also the equation for a straight line as shown in Fig. 4 whose slope is one-half that of Fig. 3 and whose intercept is the same. The intercept at V = O is $R'/\Delta P$ as before and the slope of the line is

$$\text{Slope} = \frac{\alpha\mu s\rho}{2g_c A^2(1 - ms)\,\Delta P} = \frac{R_c}{2V}$$

Since Eq. (21) involves total volumes and times, rather than instantaneous filtration rates, this is a simpler means of interpreting experimental data and resolving the total resistance into its component parts.

Constant Rate Filtration

In some cases the rate is kept constant by allowing the pressure difference to increase. Mathematically, we can express this relation by:

$$\frac{\Delta P}{R} = \left(\frac{dV}{d\theta}\right)_c$$

For constant rate filtration, the time θ_c becomes

$$\theta_c = \int_{V_1}^{V_2} \frac{R\,dV}{\Delta P} = \int_{V_1}^{V_2} \left(\frac{R_c + R'}{\Delta P}\right) dV \tag{22}$$

Since $\Delta P/R$ is constant, the filtration time can be readily determined by graphical integration as shown in Fig. 2. In this case, the area is taken between the volumes V_1 at the start and V_2 at the end and is $(V_2 - V_1)(\Delta P/R)$.

How to Estimate Washing Rates

Rate of washing can be obtained in terms of the final filtration rate.

$$\left(\frac{dV}{d\theta}\right)_f = \left(\frac{\Delta P}{R}\right)_f = \frac{\alpha\mu s\rho V_f}{g_c A^2(1 - ms)\,\Delta P} + \frac{R'}{\Delta P} \qquad (23)$$

Here the subscript f indicates the final rate. For leaf presses, rotary drum filters and similar devices, the washing rate is:

$$(dV/d\theta)_w = (dV/d\theta)_f$$

For plate-and-frame filter presses using through washing, the wash water must pass through twice the thickness as does the filtrate and only one-half the area is available. Consequently, for this case:

$$(dV/d\theta)_w = \tfrac{1}{4}(dV/d\theta)_f$$

Differences in the physical properties of the filtrate and the wash water have been neglected in the above relations.

Time for washing is then obtained from:

$$\theta_w = V_w/(dV/d\theta)_w \qquad (24)$$

where θ_w is wash time and V_w is volume of wash water.

Centrifugal Filtration

In centrifugal filters, the slurry is fed into a cylindrical basket which rotates at high speed. Filtrate passes through the cake and cloth under the action of centrifugal force. Pressure drop can be related to the rate of rotation by:

$$\Delta P_c = \frac{\omega^2\rho(r_2^2 - r_1^2)}{2g_c} \qquad (25)$$

- ω Angular velocity, radians/sec.
- ρ Density of filtrate, lb/cu.ft.
- r_2 Radius to inside of filter medium, ft.
- r_1 Radius to surface of rotating liquid, ft.
- ΔP_c Pressure drop across cake, lb./sq.ft.

Cake resistance is obtained from Eq. (2), $R_c = \mu_L/KA_L$ where $A_L = 2\pi r_L h$ and $r_L = (r_2 - r_1)/\log(r_2/r_1)$. Here r_1 is radius to surface of cake, L is cake thickness and equals $(r_2 - r_1)$, and h is depth of basket.

Substituting in Eq. (2) and using the relation $K = g_c/a\rho_c$ gives:

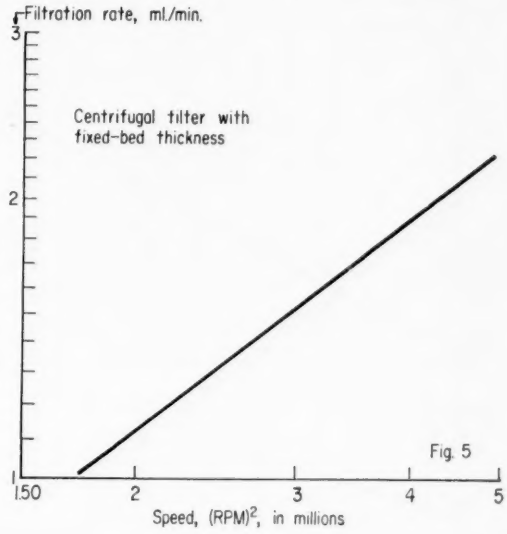
$$R_c = \frac{a\rho_c\mu}{2g_c\pi h}\ln\frac{r_1}{r_2} \qquad (26)$$

Since the total pressure drop is the sum of that occurring across the cake and the cloth, the final rate equation becomes:

$$\frac{dV}{d\theta} = \frac{\pi\omega^2 h\rho(r_2^2 - r_1^2)}{\mu\left(\frac{a\rho_c}{g_c}\ln\frac{r_2}{r_1} + \frac{R_m}{r_2}\right)} \qquad (27)$$

In Eq. (27), R_m is the resistance of the cloth expressed as ft.$^{-1}$ The instantaneous rate of filtration corresponding to the cake thickness is given by Eq. (27). Since r_1 decreases as the filtration proceeds, the rate of filtration also decreases. If the cake thickness is constant, then rate of flow of filtrate is constant.

Filter Rate Varies as Square of Speed



For a fixed cake thickness, Eq. (27) shows that rate of filtration is proportional to the square of the rate of rotation of the basket. Typical test data taken in our laboratories for flow of water through beds of styrene-divinylbenzene spheres in a centrifugal filter illustrate this relation and are shown in Fig. 5.

Examples Illustrate Filtration Relations

Problem 1—Data for the filtration of a calcium carbonate slurry were taken on a small plate-and-frame filter press to determine by experiment cloth and cake resistances. In each case the press was operated at a constant pressure. Area of filter cloth was 1.358 sq. ft. Filtrate was water having a density of 62.1 lb./cu.ft. and a viscosity of 0.77 centipoise.

Data were plotted in accordance with Eq. (21) and typical plots are shown in Fig. 6. Intercepts on this plot gives values of $R'/\Delta P$ for corresponding pressure drops.

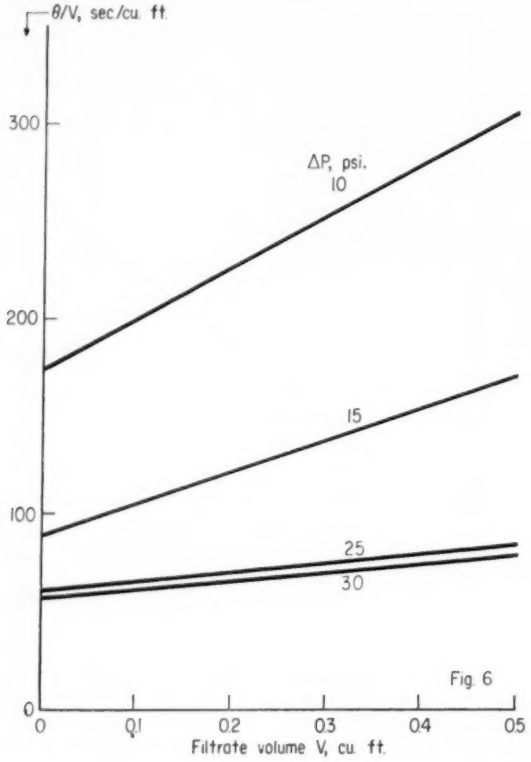
To find the cake resistance R_c, use the experimental data of Fig. 6 and Eq. (20) rearranged.

$$\frac{R_c}{\Delta P} = 2\left(\frac{\theta}{V} - \frac{R'}{P}\right)$$

Calculate specific cake resistance a by using Eq. (6) for the corresponding values of R_c. Relation of a to pressure drop is shown in Fig. 1. Results of our calculations are given in the following table:

ΔP Psi.	$R'/\Delta P$ Sec./ Cu.Ft.	R' Sec.-Lb./ Ft.^{6}	V Cu. Ft.	θ/V Sec./ Cu.Ft.	m	s	a Ft./Lb.
10	175	1,750	0.5	305	1.566	0.1651	6.2×10^9
15	90	1,350	0.5	170	1.557	0.1430	6.93×10^9
25	60	1,500	0.5	86	1.513	0.0859	7.63×10^9
30	57	1,710	0.5	77	1.535	0.0698	8.17×10^9

Use Experimental Data for Problem 1



Problem 2—Predict capacity of large plate-and-frame filter press from experimental data of *Problem* 1. A calcium carbonate slurry containing 6% solids by weight is to be filtered at a constant pressure of 20 psi. in a plate-and-frame press. The frames are 3-in. thick and 2.5-ft. square. What is the time for filtration? If volume of wash water equals one-half the volume of filtrate, what is the time required for washing? Assume that the cake and cloth have the same characteristics as those used in previous problem.

We get specific cake resistance from Fig. 1 and find $\alpha = 7.35 \times 10^9$. Next, we estimate the ratio m which equals 1.524 lb. wet cake/lb. dry cake. Hence, we can evaluate $(1 - ms)/s$ which equals 15.15.

Filtration takes place through both sides so the filter area A is 12.5 sq. ft. Wet cake density is 102 lb./cu.ft. by experiment and dry cake density is 102/1.524 or 66.9 lb./cu.ft. We can now calculate the weight of dry cake required to fill the frame from: $M_c = (3/12) \times 6.25 \times 66.9 = 104.5$ lb.
From Eq. (5):

$$V = \frac{(1 - ms)M_c}{s\rho} = \frac{15.15 \times 104.5}{62.1} = 25.45 \text{ cu. ft./frame}$$

To find cake resistance, substitute numerical values in consistent units in Eq. (6). The result is R_c equals 79,000 sec.-lb./ft.^{5} To estimate cloth resistance, use the experimental data of the previous problem. Note that R' varies inversely as the cloth area.

$$R' = 1{,}300(1.358/12.5) = 141 \text{ sec.-lb./ft.}^5$$

Hence, total resistance R is 79,141 which is the sum of cake resistance R_c and cloth resistance R'.

Using Eq. (19), we find the filtration time.

$$\frac{\theta}{V} = \frac{R + R'}{2\,\Delta P} = \frac{79{,}141}{2 \times 2{,}880} = 13.75 \text{ sec./cu. ft.}$$

Since volume is 25.45 cu.ft., total time is 13.75×25.45 or 350 sec.

To calculate time for washing θ_w, find the final filtration rate first.

$$\left(\frac{dV}{d\theta}\right)_f = \frac{\Delta P}{R} = \frac{2{,}880}{79{,}141} = 0.0364 \text{ cu. ft./sec.}$$

If through washing is used then the area is one-half that for filtering and the wash water must pass through twice the cake thickness as did the filtrate. Consequently, for this case, the wash rate is one-fourth the final filtration rate. Hence, wash rate equals 0.25×0.0364 or 0.0091 cu.ft./sec. Since volume of wash water V_w is one-half the volume of filtrate, $V_w = 25.45/2$ or 12.73 cu. ft. Hence, time for washing is 12.73/0.0091 or 1,400 sec.

Problem 3—A calcium carbonate slurry containing 6% solids is to be filtered on a rotary drum filter. The drum has a diameter of 4 ft., length of 4 ft. and rotates at 0.2 rpm. A vacuum of 20.32 in. mercury corresponding to a pressure difference of 10 psi. is applied during filtration.

At any time, the submergence of the drum is such that one-third of the total filter area is effective, the remainder is used for washing and drying the cake. Assuming that the cloth and cake characteristics are the same as those in *Problem* 1, how many pounds of dry cake per hour can be handled by this unit?

In this case, the time to be used in Eq. (20) is the effective filter time per revolution. Hence, $\theta = 60/(0.2 \times 3) = 100$ sec./revolution. From Fig. 1, find specific cake resistance α which is 6.2×10^9 at 10 psi. Effective filter area per revolution is 16.75 sq. ft.

Substitute in Eq. (6) to find cake resistance in terms of filtrate volume V.

$$R_c = \frac{6.2 \times 10^9 \times 0.77 \times 0.000672 \times 62.1V}{32.2(16.75)^2 15.15}$$

$$R_c = 1{,}473V$$

Find cloth resistance by using experimental data given in *Problem* 1. Hence, $R' = 1{,}750(1.358/16.75) = 141.7$.

Substituting in Eq. (20):

$$\frac{\theta}{V} = \frac{1{,}473V}{2(1{,}440)} + \frac{141.7}{1{,}440}$$

$$\theta = 0.512V^2 + 0.0983V = 100$$

Solving for V gives 14 cu. ft. of filtrate per revolution. Hence, $V = 14 \times 0.2 = 2.8$ cfm. Weight of cake handled by filter is $M_c = (2.8 \times 62.1)/15.15 = 11.5$ lb./min. or 690 lb./hr. of dry cake.

No. 15: Vibrating Screen Costs

H. L. Bullock, Consulting Engineer, New York, N. Y.

Basic Screen Costs Fig. 1

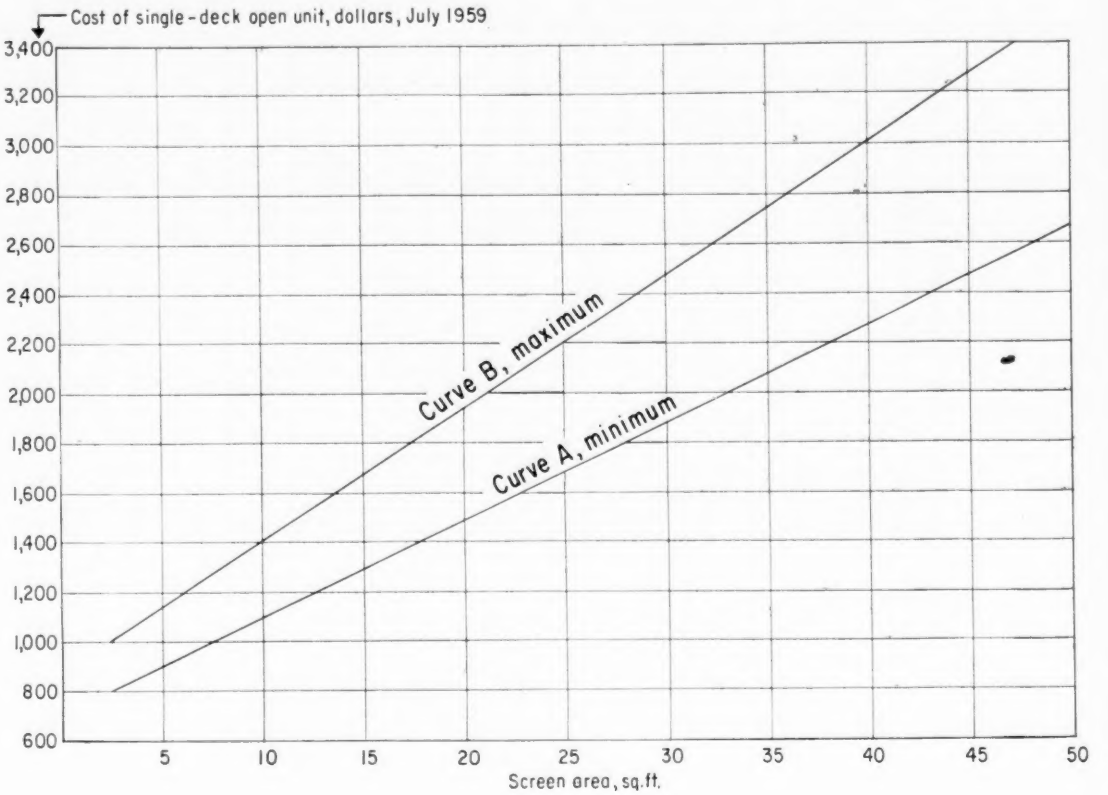
After screening area has been determined, refer to Fig. 1. Curve A is cost for the most simple, single-deck screen of open construction; curve B is cost curve for a single-deck screen of open construction that embodies the most complete refinements of adjustable slope, adjustable stroke, demountable screen decks and all-metal construction. Knowing the screening area required, read minimum possible cost from curve A and maximum cost from curve B. Standard screens are available within the price range indicated by these two curves, and you must determine the cost figure to use from a knowledge of the degree of refinement required by the particular job.

To the basic cost obtained from Fig. 1 for a single-deck screen of open construction, of the class desired, cost for additional features can be added as a percentage of basic cost:

1. For two-deck construction, add 15 percent.
2. For three-deck construction, add 30 percent.
3. For a bottom hopper, complete with discharge port, add 12½ percent.
4. For totally enclosed construction, including bottom hopper with discharge port, add 25 percent.
5. For stainless steel construction, double final cost determined above for the complete unit in size, construction and type desired.

Costs derived from Fig. 1 include V-belt pulleys for the screen and motor and connecting V-belting in standard lengths, but they do not include the necessary drive and control.

Figs. 2 & 3 on p. 156



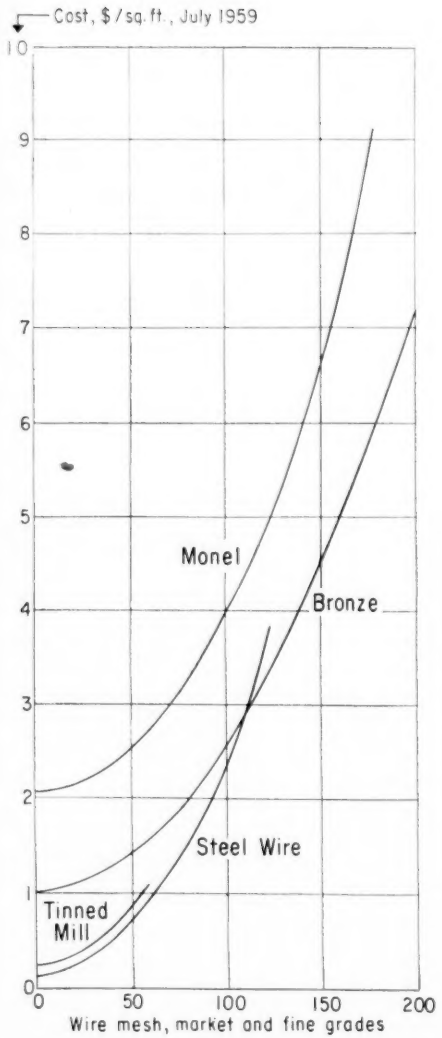


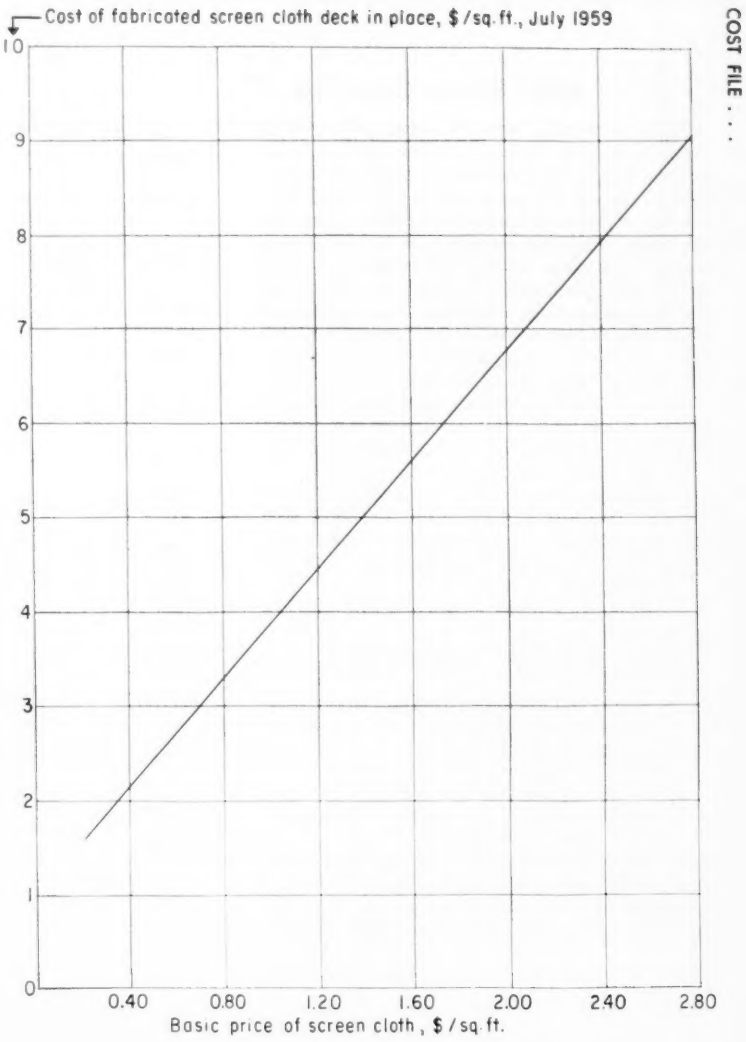
Fig. 2 Average Costs of Various Screen Cloths

Average Costs of Fabricated Screen Decks In Place Fig. 3

Screen cloth costs are not included in the costs derived from Fig. 1, since these costs show great variation on the basis of mesh, type of weave, material, percentage of open area and construction. Screen cloth costs can be determined by referring to Figs. 2 and 3. Fig. 2 gives the average costs per square foot for the standard mesh ranges of steel, tinned steel, market grade bronze and stainless steel wire cloth. Fig. 3 has been made up so that knowing the cost per square foot of any particular grade, mesh and material, you can estimate the cost per square foot of a fabricated screen deck in place in a screening unit. These estimates are necessarily rough, but will be found to be fairly accurate in covering cost of cutting for size, binding, edging and shipping.

Other factors affecting estimating of vibrating screens, including warnings about final estimating, can be found in an article that appeared in *Chemical Engineering*, June 1947, pp. 97-9.

Send your cost data to CE Cost File Editor, Chemical Engineering, 330W. 42nd St., New York 36, N. Y.



Free—For your files—Check your Reader Service postcard (p. 211) for an extra copy of this article.

Textile Technology in Chemical Engineering

Fabric Construction and its effect on filtration

In spite of the emphasis placed on *fibers* and their specialized performance, the chemical and physical characteristics of a fiber are only part of the filter-fabric's story. *Construction* of the fabric (the weave, count, yarn twist, etc.) must be given thorough consideration in the final selection of a filter fabric or the establishment of filtration goals.

Weave, for instance, is a fundamental element in fabric construction. The various weaves are the result of different systems used in interlacing the lengthwise "warp" yarns with the crosswise "filling" yarns.

The *plain* weave has a simple "one up and one down" construction. By raising or lowering the "count" (number of warp and filling yarns per inch) this weave may be made as tight or as open as necessary.

The *twill* weave is recognized by the familiar diagonal "twill" line. Twills have fewer interlacings than the plain weave, and therefore offer greater porosity—but this, again, depends on the count.

The *satin* weave has even fewer interlacings, providing smooth surface, increased porosity and high cover factor (particularly important in gaseous filtration). Cotton fabrics in this weave are commonly known as "sateens."

These basic varieties—plain, twill and satin—have many variations. But whatever the weave, performance is seriously affected by count and other factors involved in fabric construction.

Which all adds up to this: for complete information about filter fabrics, don't go it alone. Go to the nearest specialist who distributes Wellington Sears filter fabrics. He'll help—so will our more than a century of experience in serving the fabric needs of industry. And for a handy booklet of information, write Dept. L-10.

Wellington Sears Company

FIRST In Fabrics For Industry

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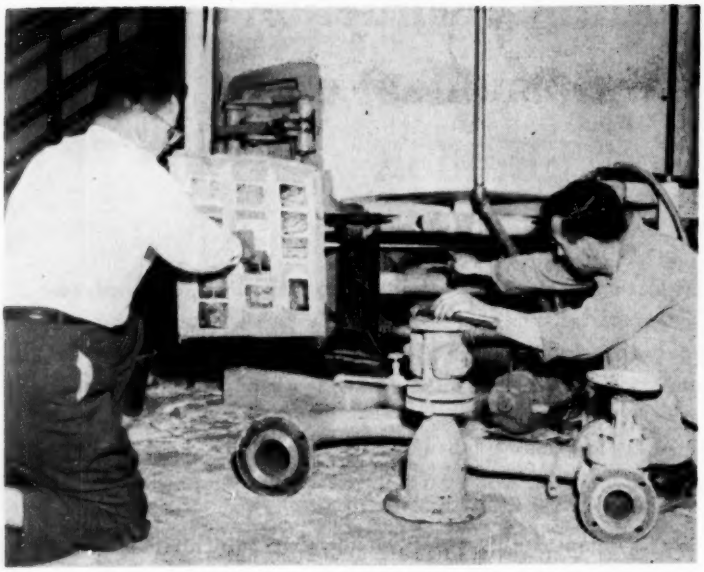
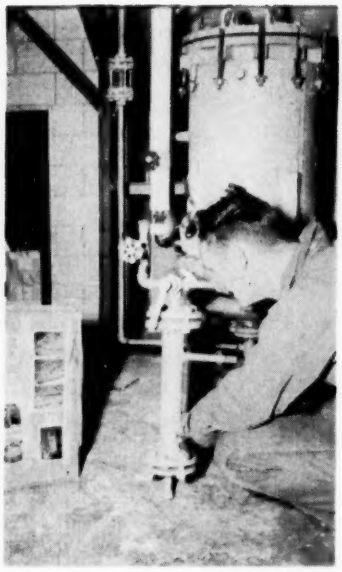




PHOTOS taken before disassembly are explained to the pipe fitters who then use them to aid reassembly.

Photos Aid in Equipment Relocation

Photos taken before disassembling a piece of equipment smooth the way for the men who must reassemble it without adequate drawings.

Charles R. Baldwin
Project Engineer, BW Plants Div., Army Chemical Center, Ft. Detrick, Md.

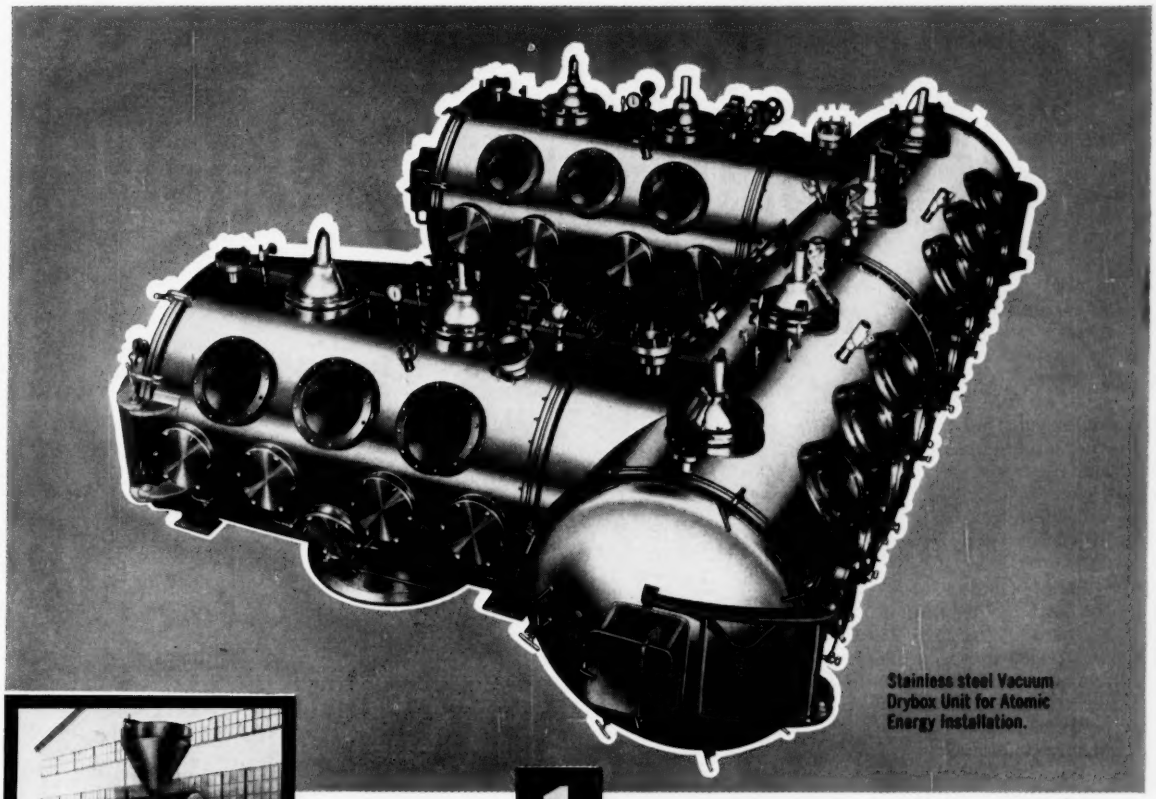
We had the problem of quickly relocating a 1,500-gal. agitated, jacketed, filter-dryer vessel, plus its process piping. On a limited budget, it was necessary to disassemble the equipment, ship it 500 miles and then reassemble it at the new location.

To further complicate matters, the available drawings were inadequate and it was out of the question to send pipe mechanics who were familiar with the setup to the new location along with the equipment.

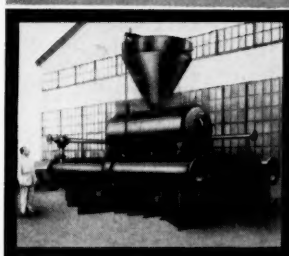
Our solution was simple, easy and satisfactory. Those concerned with the relocation took photographs before disassembly, using a Polaroid Land camera to make pictures that were developed on the spot. We tag-numbered a few key pipe sections and marked the pictures to correspond. The pictures were passed along to the pipe fitters at the new location, explained, then used in the reassembly.

If we had chosen to make the necessary drawings, the survey and drafting work would have come to $200, in contrast to the $2.25 we spent for pictures. In addition, of course, there was a large time saving.

Another sort of application for this procedure is in cases where equipment is removed for storage, to be reinstalled later.



Stainless steel Vacuum Drybox Unit for Atomic Energy Installation.



Size #10 Sulphur Burner A.S.M.E. Jacketed Melter, External Valve Mechanism, Gas & Air Manifolds.

Stainless steel Equipment and Converter Unit for Formaldehyde Plant.

220" Pressure Stock Inlet for Paper Making Machine.

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How We Solved an Oil Contamination Problem

G. M. Donahue
Chemical Engineer, Tidewater Oil Co., Delaware City, Del.

During the recent startup of a process unit in Tidewater's Delaware refinery, we encountered trouble with a leak in a compressor seal which we cured temporarily, as follows:

On startup, we found that the compressor lube oil was being contaminated with corrosive H_2S and process gases. This caused loss of viscosity of the lube oil, as well as corrosive conditions in the lube-oil circulating system.

In the compressor in question, the bearing housing is attached to the unit in such a way that seal leakage enters the housing and contaminates the lube oil. We found later that the leakage resulted from faulty "O" rings, damaged during installation.

With the compressor operating, we removed the bearing housing seal cover and found that the leaking gas could be seen bubbling into the bearing housing.

The solution was for the refinery machinery inspector to fabricate a metal suction ring made of tubing with holes drilled to receive the leaking gas. This was attached to the seal-evacuation system and positioned flush against the surface where the leaks were seen.

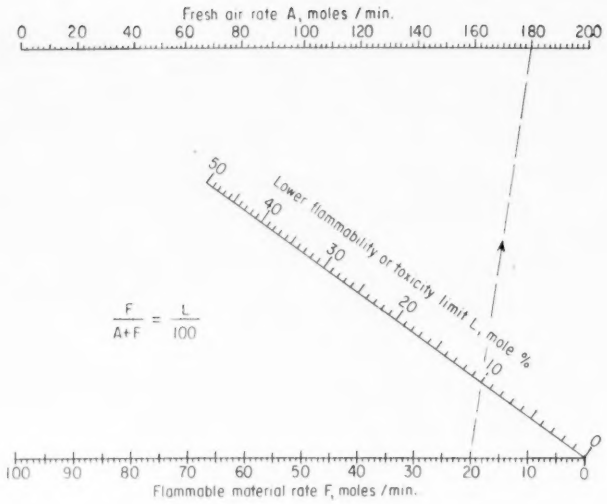
Fresh air rate A, moles / min.
0 20 40 60 80 100 120 140 160 180 200
50 40 30 20 10 0
Lower flammability or toxicity limit L, mole %
F / A+F = L / 100
100 90 80 70 60 50 40 30 20 10 0
Flammable material rate F, moles / min.

Chart Gives Ventilation Needs

Javier F. Kuong
Process Engineer, Atlas Powder Co., Wilmington, Del.

In ordinary ventilation problems, it is customary to deal with required ventilation capacity in terms of air changes per unit time. However, it doesn't necessarily follow that the correct number of air changes per hour for one inclosure will apply to another inclosure of different size. This is true when a flammable or toxic material is admitted at a fixed rate to inclosures of different sizes and it is necessary to add fresh air to dilute the material below the lower flammable limit, or the safe concentration with respect to toxity.

In such cases it is better to work in moles and proportion the incoming fresh air to the incoming toxic or flammable material so that a safe concentration is achieved. This method is therefore independent of the size of the inclosure.

From a simple mass balance we get: $F/(A + F) = L/100$, where F and A are the flow rates of the flammable (or toxic) material and the air in moles/min., and L is the lower flammable or toxic limit, in mole percent. The nomograph solves this equation, giving the minimum required fresh air ventilation rate. Handbooks such as Perry's and the "Fire Protection Handbook" give data on lower and upper flammability limits.

As an example, if the lower flammability limit of a vapor in air is 10% and the vapor input rate is 20 moles/min., the chart shows (see dotted line) that 180 moles/min. of fresh air will be required as a minimum.

Next Issue: How to Boost Available Pumping Head

By John Boresta, Winner of the August Contest

★ How Readers Can Win

$50 Prize for Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebooks.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.

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$BF_3 \cdot C_2H_5NH_2$ Crystalline solid, m. p. 89°C.

This and other amine complexes of BF_3 find use in elevated temperature curing of epoxy and other types of resins. By dissociating at elevated temperature by the follow reaction:

$$BF_3RNH_2 \rightarrow BF_3 + RNH_2$$

the release of BF_3 can be controlled, allowing control of the cure. These materials are suitable for anhydrous systems.

ZINC FLUOBORATE, 40% SOLUTION, $Zn(BF_4)_2$

used for curing resins on cloth to achieve "wash and wear" finishes. Here, again, the activity is due to release of BF_3 at elevated temperatures.

$$Zn(BF_4)_2 \rightarrow 2BF_3 + ZnF_2$$

Useful for emulsion applications that will be followed by heat curing.

INORGANIC COMPLEXES

Ammonia
Orthophosphoric Acid

ALIPHATIC AND ALICYCLIC N COMPLEXES

Ethylamine
Piperidine
Triethylamine
Tri-n-butylamine

ALIPHATIC N + O COMPLEXES

Acetamide

ALIPHATIC AND ALICYCLIC OXYGEN COMPLEXES

Acetic Acid
Ethanol
Tetrahydrofuran

AROMATIC N COMPLEXES

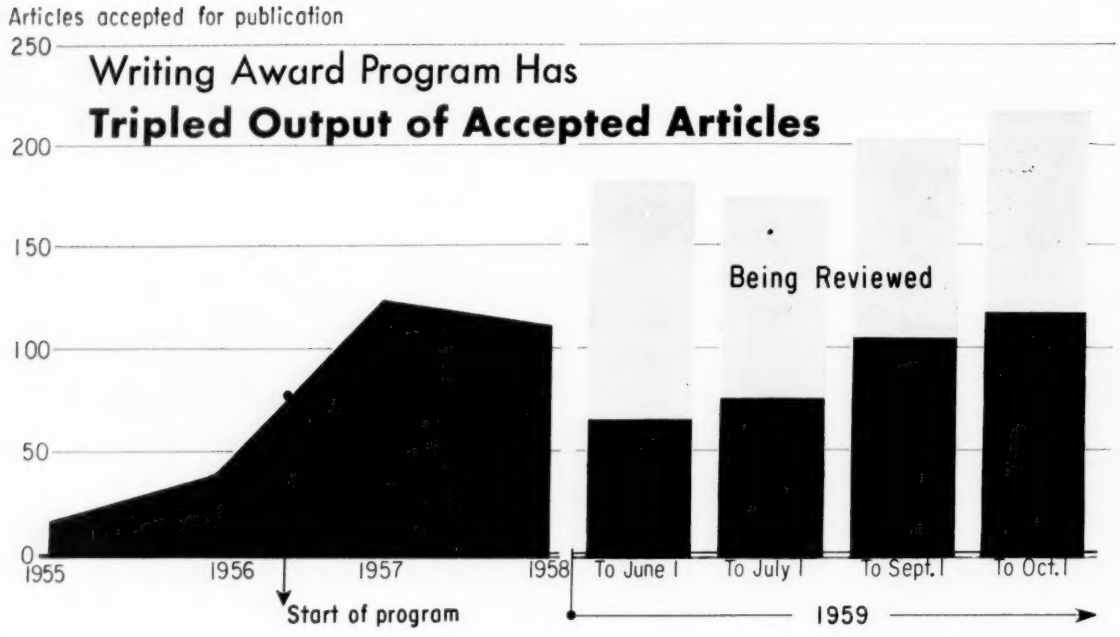
Pyridine
Aniline

AROMATIC OXY COMPLEXES

Phenol

HARSHAW

The Harshaw Chemical Co.



How We Encourage Engineers to Write

Here's proof positive that given proper challenge and reward engineers can be stimulated to author technical articles that enhance professional status and company prestige.

Nelson Fuller, Convair, Div. of General Dynamics Corp., San Diego, Calif.

The idea of an award program to encourage the preparation of articles by technical employees is not new.

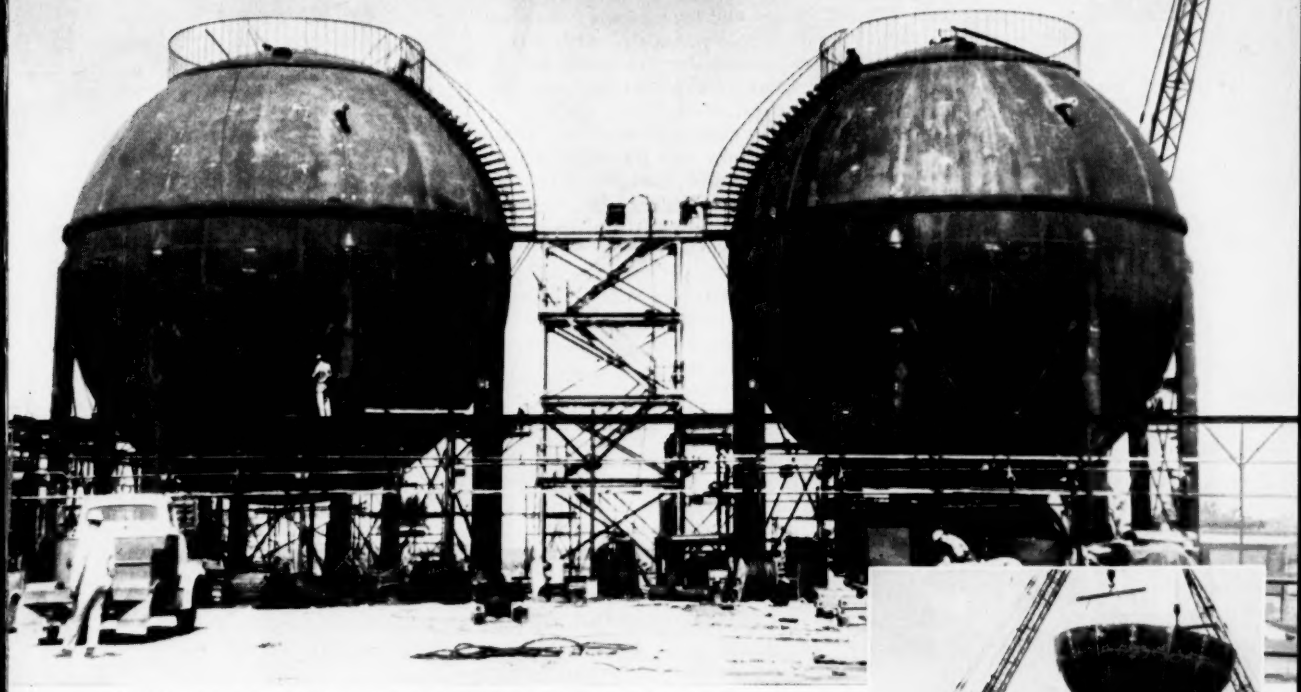
For nearly 20 years, the Dravo Corp. has conducted a writing award plan. It originally began as a "Technical Papers Competition" in which contributions from company personnel were judged and cash awards made for the best papers.

Other companies that sponsor writing award programs include: Du Pont, General Electric, Monsanto, Humble Oil, IBM, RCA and the Carborundum Co.

And then there're the Bell Telephone Lab engineers who really go all out as a writing team. In 1957, more than 600 articles by Bell technical staff members were published in technical journals and business publications.

▶ **Comparative Newcomer** — Although Convair is a comparative newcomer to a program like this, I'd like to describe our writing fund award program. Now in its fourth year of opera-

HOW TO STORE LIQUIDS AT -320°F.



CB&I Hortonspheres built for cryogenic storage are spheres within spheres.

CB&I-built HORTONSPHERES® do it for Linde at Pittsburg, California

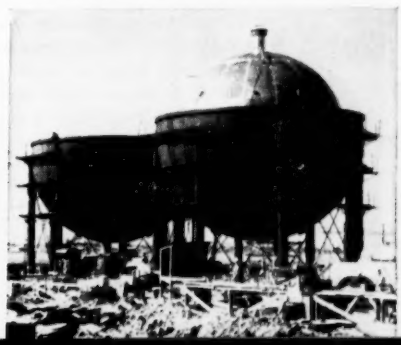
CB&I engineered, fabricated and erected these special Hortonspheres for Linde's new plant at Pittsburg, California, using Linde-approved designs. One is used to store liquid oxygen at —297° F. The other will store liquid nitrogen at —320° F.

Their construction is unusual . . . each structure is actually a sphere within a sphere. A specially designed rod support system cradles the 38'9" diam. aluminum inner sphere within the 46'9" diam. carbon steel outer shell. Heat transfer to the inner sphere is minimized by powdered insulation placed between the inner and outer shell.

Cryogenic storage calls for vessels of special design . . . and the know-how to build them. Linde Company used this know-how from CB&I's seven decades of craftsmanship in steel. So can your company. Write for further details.

Photo taken during erection shows cranes setting section of aluminum inner sphere.

Above and below: Experienced CB&I erection crews make tough jobs look easy.



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OFFICES AND SUBSIDIARIES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

tion, it has already chalked up some amazing results.

Why did we decide to initiate a writing award program? What benefits accrue from such a plan? How have authors and Convair fared in carrying it out? Why should an individual take the time and effort to research and write a technical article in the first place?

This article will present the answers to these appropriate questions.

▶ **Remember the Shortage** — You'll recall that during the earlier years of this decade a great hue and cry went up all over the land because of a reported shortage of engineers, scientists and technically trained personnel.

Like many other employers of engineers and scientists, Convair felt this shortage. Our engineering recruiting teams fanned out from San Diego to the furthest parts of this Nation.

We bought our share of newspaper and magazine advertising space to compete with other companies for the personnel we needed in engineering, scientific and allied technical fields.

However, the question arose as to how our public relations dept. might best fit into this recruitment program; to supplement the efforts of the engineering dept. in the search for talent.

▶ **Like Attracts Like**—We were aware that just as "like attracts like," good engineers attract good engineers.

We were also aware that there existed in Convair a reservoir of good engineering talent. However, we realized that these people hadn't been given the opportunity to write, nor the pat-on-the-back from the company essential to put their writing talents to work in such an extracurricular field.

Too, we were aware that they didn't have available to them the assistance in preparing articles, much less advice and counsel in distributing them to publication media.

In brief, in order to help attract high-caliber people to Convair, we decided to launch a company-wide program calling for the preparation of technical articles by our engineers for publication in the technical and business press.

The articles would carry the authors' bylines, and the company's name in conjunction with authors' titles.

▶ **Emphasize Competency** — By their very subject matter, these articles would emphasize the competency and capability of our engineers. They would point up Convair as a forward-looking company, utilizing the best brains available.

Employee morale would benefit by a program that would make it easier for our personnel to tell their story in print and to realize that the company encourages this and is willing to help in every possible way.

Two additional byproducts would be:

- Publication of technical articles would enhance an author's professional reputation and prestige as he wrote about original contributions he or his group may have made.
- The plan would provide a reservoir of material for the editors of publications. (More about this later.)

▶ **How to Start Action** — You say, "This is all very fine, but how do you get this potential writing team into action?"

We recognize that our engineers are hired primarily to design, develop, test and produce aircraft and missiles. We can't ask them to write for us on company time, for that isn't their business. Obviously, we can't ask them to write for us on their free time—simply for the glory of Convair.

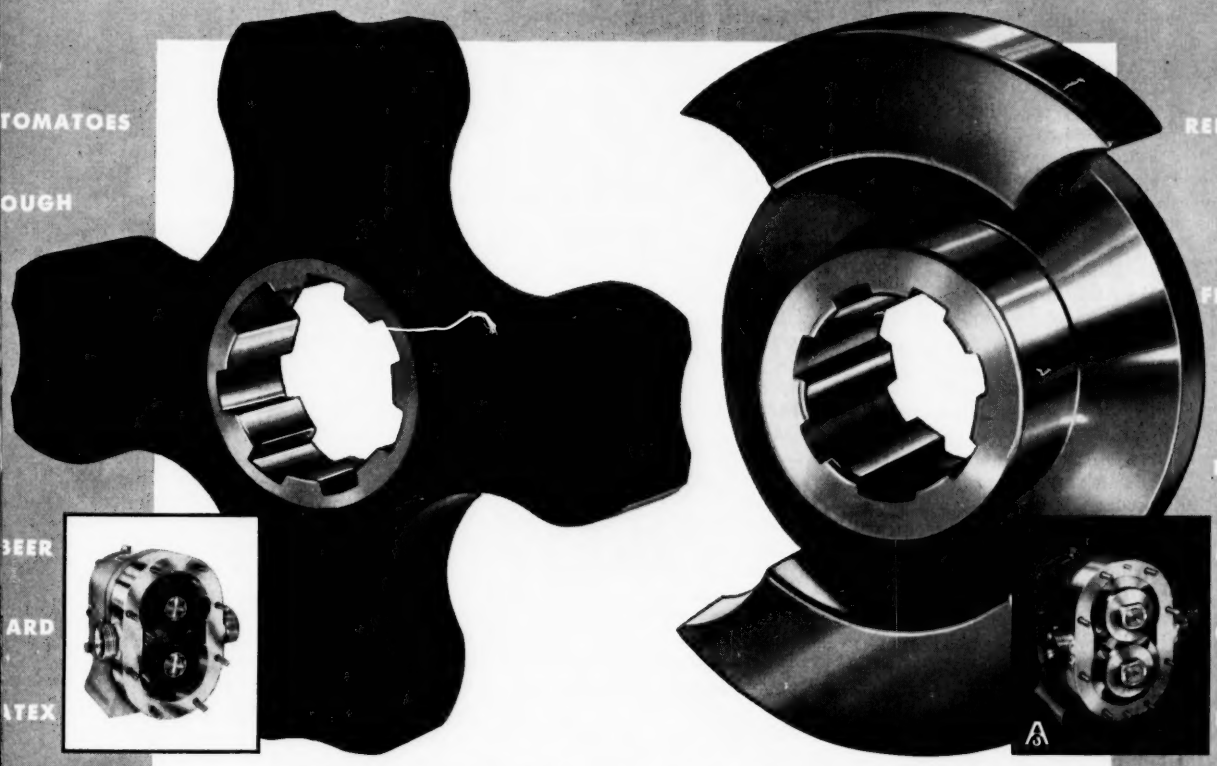
Before our present plan was set up, an author might send his article to the magazine he suspected would pay him the best honorarium. However, the article might have been more ap-

How Publication Enhances Professional Stature

C. F. Savage, General Electric's consultant for engineering professional relations

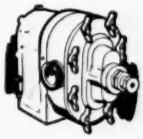
1. **Technical article** preparation provides a record of work done and of others' appraisal of a writer's efforts.
2. **Publication** of an article and the resulting extension of an author's knowledge benefits many, as follows:
   - Puts the author in touch with others having like interests.
   - Stimulates constructive discussion and studies of projects in progress.
   - Makes timely information available to many.
3. **Writing** technical papers builds personal prestige and grants recognition to individuals. Other derivative benefits:
   - Writers may often become consultants.
   - Publication of articles may be considered in salary reviews.
   - Articles may be used as references in professional registration, when applying for a new position, for membership in technical societies.
4. **Engaging in writing** programs promotes individual satisfction with these direct byproducts:
   - Author obtains a better understanding of the literature in his own field. As he puts his own thoughts on paper, he gets a self-education in orderly thinking.
   - Articles of merit are considered for awards, medals and certificates offered by technical and professional societies.
   - Authors assist in patent procural, since publication sets the date of the first public disclosure.
   - Improvement in self-expression, by oral practice in persuasion in selling his ideas, and through practice in expressing his ideas in writing.
5. **Payment** for the article may, of course, be another direct benefit to the author. This may come from the publisher, or from his employer's writing fund award program.

Which Pump is best for your Product?

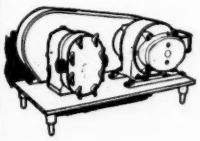


only WAUKESHA offers you a choice of rubber or metal impellers

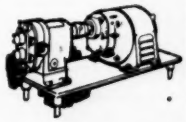
Your product demands a *specific* size and type positive displacement rotary pump. The proper selection is the most important factor in obtaining *maximum* pump life and the assurance that your plant keeps on stream—always.



Only WAUKESHA offers you *more than* 500 positive displacement pump combinations . . . a type and size *specifically* engineered to handle your product. You select *exactly* what you need . . . no compromising—ever.

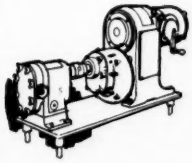


Only WAUKESHA offers you a choice of metal or rubber impellered pumps for capacities from 0 to 300 G.P.M.

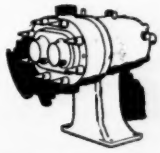


Only WAUKESHA offers you corrosion-resistant pumps in both Waukesha Metal (nickel alloy) or 316 Stainless.

Only WAUKESHA provides the specialized engineering assistance built on more than 5 decades of experience in the design and manufacture of positive displacement rotary pumps.



Representatives in all major cities. Call your distributor or write . . . Waukesha Foundry Co., Dept. 35, Waukesha, Wis.



WAUKESHA FOUNDRY COMPANY

The largest producers of sanitary positive displacement pumps

TOMATOES DOUGH BEER ARD ATEX ILK CHEESE ORN SYRUP FRUITS HEMICALS ARD STARCH GS SAUSAGE IQUID SUGAR FROSTING

RELISHES BEER FRUITS EGGS LARD MILK GLUE PAINT LATEX SAUSAGE STARCH GLUE RELISHES TOMATOES PAINT BABY FOOD DOUGH COSMETICS MAYONNAISE

propriately placed in a magazine that paid less, or perhaps not at all.

We arrived at the conclusion that monetary considerations should be eliminated, as far as possible, in deciding to which publication an article should be submitted.

▶ **Pay a Set Amount**—Thus, we decided to pay a set honorarium. This way the company would have greater freedom in selecting a market for articles.

And the authors would be assured of a monetary reward for their efforts, in many cases above the "going rate" for such material.

So with these guidelines—and the blessing of top management — the Convair Writing Fund Award Fund was established in May 1956 as a going operation. We are now in our fourth year of successful operation.

▶ **Who's Eligible?** — Now for some of the mechanics. Who's to take part in the program?

Any employee whose normal duties do not include the preparation of articles for publication in noncompany journals may participate in the program.

But material is restricted primarily to subjects of specific interest to our industry; for example, to the design, testing, production and operation of aircraft and missiles and their systems; to allied fields, such as thermodynamics, aerodynamics, hydrodynamics, etc.; to general interest subjects, like plant engineering, personnel management or improved packaging methods.

The articles must be written on an employee's own time. Minimum acceptable word count is 1,500; somewhat less if accompanied by art. Nor would we penalize an author if his 1,500-word article turned up in print condensed, say to 1,200 words. We would still pay the full amount.

The author must obtain, by his own efforts, whatever charts, diagrams or photos are required to illustrate his paper. Manuscripts are checked by the author's immediate supervisor. They are checked by engineering and industrial security to be sure that classified information is not revealed. They are reviewed by the patent dept.

▶ **Middleman Helps**—The company encourages authors to submit their material through General Office Public Relations as the most practical approach in getting a manuscript accepted. We are in a good position to channel each article to a publication that is likely to give it the best acceptance, and especially to keep track of the number of articles sent to any one magazine at a given time.

In this connection, articles are referred to additional publications until they are accepted. But the author's preference—if he has one—determines the selection of the first magazine to which his manuscript is sent.

▶ **What We Pay**—Any employee who has met the requirements of the program and has had his article accepted receives a check from Convair for $150, less any necessary deductions. Net is about $130.

We purposely set this figure somewhat higher than what most publications pay, because we wanted our people to realize the importance the company attached to the writing of technical articles.

(As you are aware, most magazines pay in the neighborhood of $15-$25 per printed page.)

Payment is made upon acceptance of the article in its final form, rather than at the time of publication. Often there is a delay of several months before an editor can schedule an article for publication. There's no need to penalize the author for this.

Another stipulation is that we do not permit our authors to accept fees from the magazine in addition to—or in place of — remuneration from the Writing Award Fund.

▶ **Low Reject Rates**—So much for the mechanics of the plan. How have we fared since 1956? The chart on p. 162 tells the story.

You'll be interested to learn that the rejection rate is an incredibly low estimate of 5%. For even though an article may be rejected once, twice or three times, we still attempt to place it and eventually do. All, that is, except for one which has been turned down by five publications and which I've returned to the author from utter despair.

Out of sheer curiosity, we checked circulation totals for the 114 magazines accepting Convair articles in 1958. Total circulation was 2,227,000.

Let's go one step further and estimate the cost of placing one-page black-and-white advertisements in the magazines accepting these articles, and assuming that each of the 114 articles ran 2½ printed pages. It would have cost us approximately $138,000 for equivalent advertising space.

All this on a writing fund award budget of $20,000 a year.

▶ **What the Author Gets**—This sounds fine for Convair, but what about the author?

Is it worth the effort for him to take time away from his family on weekends, or at night to research and put together a technical article? In the box on p. 164, you'll find the answer to this question.

Thus all parties gain by participation in a company-sponsored award program: the author, the company and the publications.

With respect to the last, I said earlier that Convair is fast becoming a reservoir for available manuscripts. This is especially true with respect to material that is sought by a publication of its own accord.

It is our belief that publications seek this special material from us because of the high-quality manuscripts they have come to expect from our personnel. In any event, it gives us pride to know that we are asked to contribute these articles.

Let me close with a thought by Peter J. B. Stevens as published in the May 1959 issue of *Industrial Marketing.*

"Today's engineer must literally educate himself on a day-to-day basis to keep abreast of the work in his field. And in this continual self-education, technical publications are his textbooks. They are the medium by which engineers exchange current information of common interest."

Need I say more?

APPLIED EXPERIENCE

is an invaluable design factor of every

MARLEY CROSS-FLOW DOUBLE-FLOW

The future of an industrial cooling tower is no better than its background. Its performance and service life are dependent wholly on the practical experience and specific product knowledge of the people who design it. This suggests that you consider people as carefully as you consider price if you are to receive full-value returns from your investment.

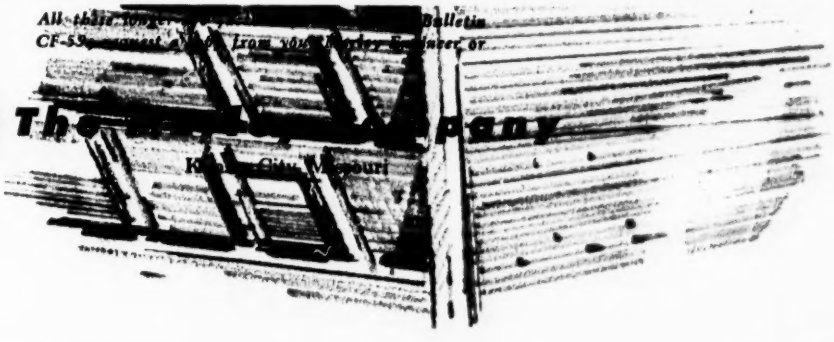
When you buy a Marley Double-Flow, qualified people and abundant experience are basic parts of your purchase. You contract for the services of the industry's largest staff of engineering specialists, and each member—from years of specialization in thermal performance, structural and mechanical design, or application economics—contributes materially to the *true* value of the product you buy.

Of equal importance is the company's overall experience gleaned from designing and building 6,854 fan cells of large capacity industrial Double-Flows in the last 21 years . . . the sound basis of all Marley engineering. The only adequate file of authentic information on cross-flow cooling is the service history of all these installations. It evaluates every advancement and innovation in cross-flow cooling and, of course, is available only to Marley engineers.

At its Research Center, the company accelerates the acquisition of experience. In this excellently equipped facility, 30 engineers and technicians intensively test and analyze materials, equipment, components, complete towers; they scientifically appraise the value of theoretical approaches to new standards of cooling performance and operating economy. From experience gained through this program, Marley develops the steady flow of design advancements that pace the industry.

The ability of Marley people to apply their extensive experience to cooling tower design is demonstrated by the results of tower tests made public annually. Year after year, they prove that Marley Double-Flows — THE ONLY TOWERS WITH A PUBLISHED RECORD OF PERFORMANCE—consistently meet the most exacting specifications of purchasers in every industry.

MARLEY



Marley Co.

COOLING TOWER maintenance can be cut way down with a well planned water treatment program that gives you maximum protection at minimum operating costs.

Cooling Water Treatment

. . . Cuts Operating and Maintenance Costs

P. G. Ketcham, Sr. Gas Engineer, Gas Engineering Div., Humble Oil & Refining Co., Houston, Tex.

A well designed water treating program will control scale formation, corrosion, microbiological growths and chemical deterioration of cooling tower lumber.

Fouling of critical heat exchange surface with scale or bacteriological growths reduces the rate of heat transfer and results in an appreciable loss in plant income.

Uncontrolled water-side corrosion may result in premature failure and early replacement of expensive heat exchangers, water piping and pumping equipment, as well as a loss of plant products until necessary repairs are made when plant shutdown is involved.

It follows: a sound program of water treating and cooling tower maintenance pays dividends. You can develop such a program only through proper planning.

Your plans should include selecting the most effective and economical treating method, and then, proper maintenance of equipment.

Cost Is Important

How much you treat cooling water is really a matter of economics. Given a source of make-up, you can adjust the quality of cooling water and control it to any degree of purity—for a price.

You must justify water treating equipment investment and operating costs by a reasonable pay-out just as you justify any other plant facility. In a typical plant: water-cooled heat exchangers, cooling towers, water distribution systems, circulating pumps and other water handling equipment may represent as much as 20% of the total major equipment cost or 10% of the total plant investment.

Therefore, proper treatment and conditioning of water for use as make-up, represents an important phase of plant operation, and reasonable water treating costs are easily justified.

In a new plant, for instance, you can initially justify water treating equipment and operating costs by reducing the amount of heat exchanger surface.

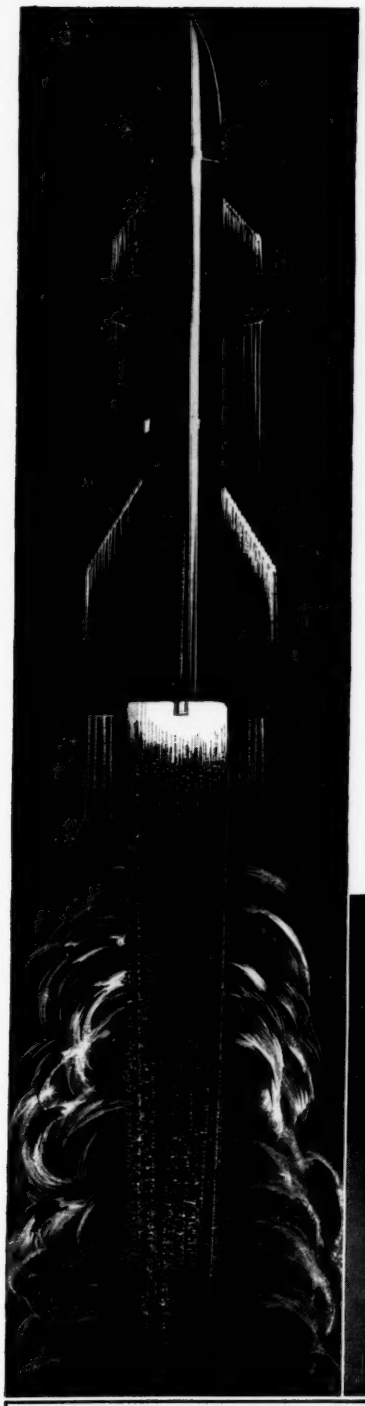
Assume, for example, that anticipated cost of a proposed plant is $10 million. For a given process, the water-cooled exchangers in a plant of this size, designed with a fouling factor of 0.002, may represent an installed cost of $800,000.

If, through improved water treatment, fouling factors of 0.001 could be safely used for design purposes, attendant reduction in heat exchanger surface, amounts to investment savings of approximately $90,000.

Savings of this magnitude alone, when projected over an assumed project life of 20 years, are more than adequate to cover normal daily treating costs.

First, Scale Control

Scale is an adherent insoluble deposit caused by precipitation or crystallization of salts from the circulating water



at Callery's new HiCal® plant

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work full-time to produce

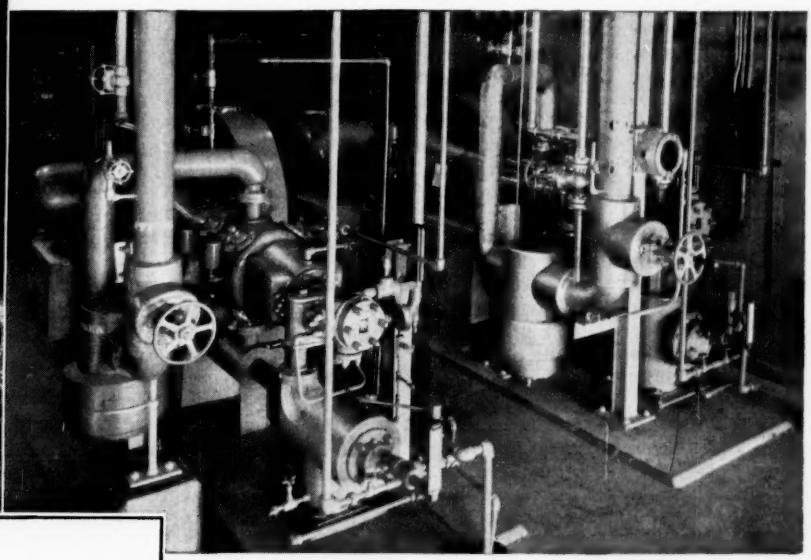
NEW HIGH-ENERGY FUEL

Recently the U.S. Navy and the Callery Chemical Company jointly dedicated their new HiCal plant in Muskogee, Oklahoma—America's first large-scale facility for the production of boron-based high-energy fuel. This new exotic fuel will power missiles, super aircraft, and possibly even man's first steps into space.

A large assortment of Ingersoll-Rand process compressors and pumps at Muskogee are working around the clock to maintain a continuous production schedule. One of the major processing units is the gas plant which produces hydrogen, carbon dioxide and nitrogen. Here a new-design Ingersoll-Rand ESH two-stage compressor handles carbon dioxide at 305 psig discharge, and another two-stage I-R unit compresses nitrogen to 500 psig. Two three-stage TVH's compress the hydrogen to 310 psig.

The Muskogee plant also includes 47 Ingersoll-Rand centrifugal pumps of various types and ratings.

Ingersoll-Rand's leadership in the manufacture of process equipment is the result of the world's most comprehensive compressor experience. Ingersoll-Rand now makes the widest range of compressors of all types, including reciprocating, centrifugal, axial-flow and jet units. Your Ingersoll-Rand representative will be happy to give you more information on gas or air compressors for any process requirement.



Ingersoll-Rand two-stage compressors at the new HiCal plant. At left, an ES nitrogen compressor; at right, compressing carbon dioxide, is an ESH unit of revolutionary new design.

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stream. Factors influencing formation of scale are temperature, heat transfer rate, pH and naturally occurring impurities in the water.

Calcium carbonate scale is usually the worst offender in an open recirculating system because of its low solubility. In addition, solubility of $CaCO_3$ is inverse; that is, it's less soluble at higher temperatures. This phenomena is important in a cooling system since precipitation invariably occurs on hot heat exchanger tubes.

Although $CaSO_4$, $CaSiO_3$ and $MgSiO_3$ are also potential scale offenders and deserve consideration, their solubilities are considerably higher and in most controlled water systems don't present a problem.

In an open recirculating system, evaporation in the cooling tower further complicates matters by concentrating scale forming ions. Once the equilibrium solubility of $CaCO_3$ is reached, further concentration results in its precipitating and depositing throughout the system.

Most make-up water contains enough of a residual of calcium hardness and alkalinity that after the circulating water has been concentrated from four to six times, scale deposits occur unless you take steps to maintain a residual below the saturation point.

Some of the more common methods of controlling the residual of calcium carbonate within safe limits in an evaporation-type cooling system are: blowdown, external removal of hardness by total or partial softening, internal treatment with surface active agents, adding H_2SO_4 to control the alkalinity and various combinations of the above four methods.

Although in some cases it's possible to control formation of scale with excessive rates of cooling tower blowdown alone, this procedure is rarely economical. This is particularly true when the cost of make-up water is high or when corrosiveness of the water demands corrosion inhibitors.

Type or combination of treating procedures depends on the quality of each individual source of make-up water.

For example, a source of ground water that contains considerable hardness, alkalinity and iron—all potential scale offenders—is ideally suited to cold lime softening. This usually reduces each of these impurities to a suitable level for cooling tower make-up. When coupled with internal treatment of surface agents, H_2SO_4, corrosion inhibitors and blowdown, as required, this treatment provides a scale-free cooling system.

Then, Stop Corrosion

Corrosion in a cooling system results in costly piping repairs, premature replacement of expensive equipment and higher pumping costs due to increased frictional resistance in the piping.

While uncontrolled corrosion is serious in any cooling system, it's particularly critical in thin-wall carbon steel heat exchanger tubes.

In general, the factors influencing corrosion in a cooling system are temperature, rate of water flow, contact of dissimilar metals and water quality. Characteristics of the water that contribute to corrosion are dissolved oxygen and CO_2, pH and dissolved solids.

In a cooling tower system, the most prevalent undesirable characteristic is usually dissolved oxygen since the water is aerated each time it passes over the cooling tower.

Since most water system corrosion occurs as a result of electrolytic action, an increase in the dissolved solids content or conductivity enhances corrosion. This is particularly true of chloride and sulfate ions.

Higher rates of corrosion are usually experienced on hot water outlets of condensers and hot water return lines to the cooling tower. This is primarily from the decrease in water viscosity at higher temperatures which increases the rate of oxygen diffusion.

Higher water velocities also influence the corrosion rate by bringing larger volumes of oxygen into contact with the cathodic surface.

Galvanic corrosion from the contact of dissimilar metals, is significant in systems equipped with copper alloy tube heat exchangers. Steel tube-sheets, baffles, channels, channel covers and associated piping are sacrificed due to a lower electrode potential.

Because of the many factors that influence the rate of corrosion, it's often difficult to predict the corrosiveness of a cooling water stream by water analysis alone. A more positive approach to the problem is to conduct a corrosion survey immediately after the system is placed in operation. Determine actual corrosion by the time exposure of test coupons throughout the system or by using more recently developed corrosometers.

There are currently available on the market many proprietary chemicals and treating procedures for the inhibition of waterside corrosion. Some of the more generally employed treating methods include phosphates, chromates, phosphate-chromate combinations and chromate-organic-inorganic combinations.

Economics of any corrosion inhibition program is justified by reasonably extending the service life of the equipment protected.

Biological Problems Enter

Microbiological control in a cooling tower system is usually confined to bacteriological slimes and growths of algae.

Slimes are gelatinous masses that come from the action of bacteria on food materials in the system. They generally form in the water distribution piping and heat exchangers.

Algaes are a low form of plant life. Their growth is generally confined to areas in the cooling system exposed to light and air. However, there are forms of algae that don't require light or air for existence, and these species are also found in water piping and heat exchanger bundles.

These micro-organisms are very troublesome in a cooling tower system. Slime deposits seriously reduce the flow of water and retard the rate of heat transfer through heat exchanger tubes. Result: reduced plant efficiency.

Dateline: Formosa

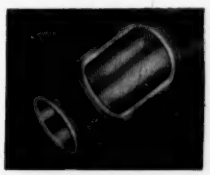
Bridgeport Duplex Tubes Solve a Chinese Corrosion Puzzle

The recently completed urea plant for Taiwan Fertilizer Company, Ltd., on Formosa, will increase fertilizer production so necessary to the Chinese Nationalist agricultural economy. Designed according to the Inventa-Vulcan process, the urea synthesis section of the huge installation utilizes a number of specially designed heat exchangers in various processing steps.

One of the many problems that had to be faced was to find a heat exchanger tube capable of meeting the combined corrosive attack of both the cooling water and the process stream. The natural corrosive qualities of water in the raw state were heightened by the periodic injection of chlorine to kill living organisms. The process fluid, on the other hand, presented an entirely different set of problems. No single alloy could cope with both corrosive media. As is often the case in such circumstances, the solution was found in Bridgeport Duplex Tubes made by drawing two different alloy tubes to form one mechanically bonded bimetal tube.

The effectiveness of Bridgeport Duplex Tubes in such applications as chemical processing, refineries and food processing, is as widespread as their use. They are available in a wide variety of alloy combinations to meet virtually any corrosive problem.

For full details, call your nearest Bridgeport Sales Office or write direct for the new BRIDGEPORT DUPLEX TUBE MANUAL. Dept. 5011



Bridgeport Duplex Tubes are bimetal tubes—two tubes combined into one. With them, you can select the metal alloy surface best suited to meet the corrosive attack to which it is exposed.

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Slime and algae clog piping and cooling tower distribution systems causing increased pumping heads and reduced cooling tower performance. Slime growths also contribute to corrosion in the system by providing a barrier to the corrosion inhibitor.

Slime and algae growths are controlled primarily with chemical algaecides. Some of the more commonly used algaecides are chlorine, $CuSO_4$, phenolic compounds and quarternary-ammonium compounds.

Due to the many species of bacteria found in a single cooling system, each of which react differently to a certain toxicant, selecting an algaecide is still somewhat empirical.

Chlorine is probably the most widely used algaecide, primarily because of its toxic effect on a wide variety of bacteria, low cost and the fact that no problems of pollution are involved in cooling tower waste disposal.

Copper sulfate is also one of the older and more widely used disinfectants. Although $CuSO_4$ is an effective low cost bactericide, it does, however, have several disadvantages.

The copper ion is corrosive to ferrous metals and must be used with discretion in the system. It precipitates readily to ineffective, insoluble $Cu(OH)_2$ at higher pH values and is toxic to fish and waterlife.

Sodium pentachlorophenate is an effective noncorrosive algaecide. It's toxic properties are least affected by characteristics of the water, and other advantages extend to action against various wood destroying fungi. However, this chemical is extremely toxic to fish and to a lesser extent livestock, and must be used accordingly.

Quarternary-ammomium compounds are also effective and are nontoxic to fish and livestock when used in recommended dosages.

Continued use of one disinfectant doesn't, as a rule, adequately control slime and algae. Shock treatments with the normally used bactericide as well as combinations of the various available toxicants, in general, provide a more satisfactory program.

Watch for Deterioration

Water treating methods selected for the control of scale and microbiological growths should also consider maintenance of cooling tower lumber.

Circulating water with excessive residuals of carbonate and bicarbonate alkalinity remove the lignin binder in redwood.

Excessive residuals of chlorine for control of microbiological growths is also detrimental to cooling tower lumber. Chlorine reacts with the lignin binder in redwood to form chlorolignin which is soluble and removed by the circulating water. Chlorolignin thus formed, is more soluble in an alkaline solution and a combination of high alkalinity and excessive rates of continuous chlorination accelerate deterioration.

Result is early failure of cooling tower lumber in flooded sections of the tower.

Excessive residuals of chlorine and alkalinity also selectively remove and destroy the natural preservatives in redwood. Once the inhibiting preservations are leached from the wood, it's subject to bacteriological deterioration.

Cooling Tower Maintenance

Redwood lumber has been used for many years in the construction of cooling towers because of its dimensional stability and resistance to decay under wet, humid conditions.

While progress has been made in the development of suitable wood preservatives and substitute materials for new cooling towers, industry is currently faced with maintaining and extending the service life of existing structures.

There appear to be currently available only two types of bactericidal treatments successfully applied to control the wood destroying fungus in existing towers.

One such treatment consists of applying a combination of water soluble chlorinated phenols. Circulating water is batch treated periodically with extremely high concentrations to inhibit biological surface attack of lumber in the flooded sections of the tower. The plenum chamber is sprayed with a stronger solution at three- to six-month intervals.

Toxicity of chlorinated phenols apparently control the reproduction of micro-organisms; however, the phenols are water soluble and leach readily from the wood which accounts for repeated applications. In many cases, the cost of repeated applications and the difficulty of the toxic effluent disposal make this treatment undesirable.

The other treatment showing promise as a wood preservative was developed by the Forest Products Laboratory for treating fence posts.

In general it consists of first diffusing a saturated solution of $CuSO_4$ into the surface of prewetted wood followed by a saturated Na_2CrO_4 solution. These fairly soluble chemicals react in the surface of the wood to form an insoluble precipitate which is toxic to fungi.

You can apply this double diffusion treatment to the affected areas at a reasonable cost. Test work to date, indicates toxic residuals after three to five years of exposure.

Treatment of lumber, already badly infected with internal fungus, will not deter its deterioration. The only corrective measure to prevent further infection and insure structural stability and performance of the tower is to remove and replace deteriorated lumber.

Replacement of deteriorated lumber presents many problems. First, the tower must be thoroughly inspected and the scope and estimated cost of repairs determined.

Before plans and specifications are prepared and proposals for repair work obtained, consider the age of the tower and future performance required by the plant.

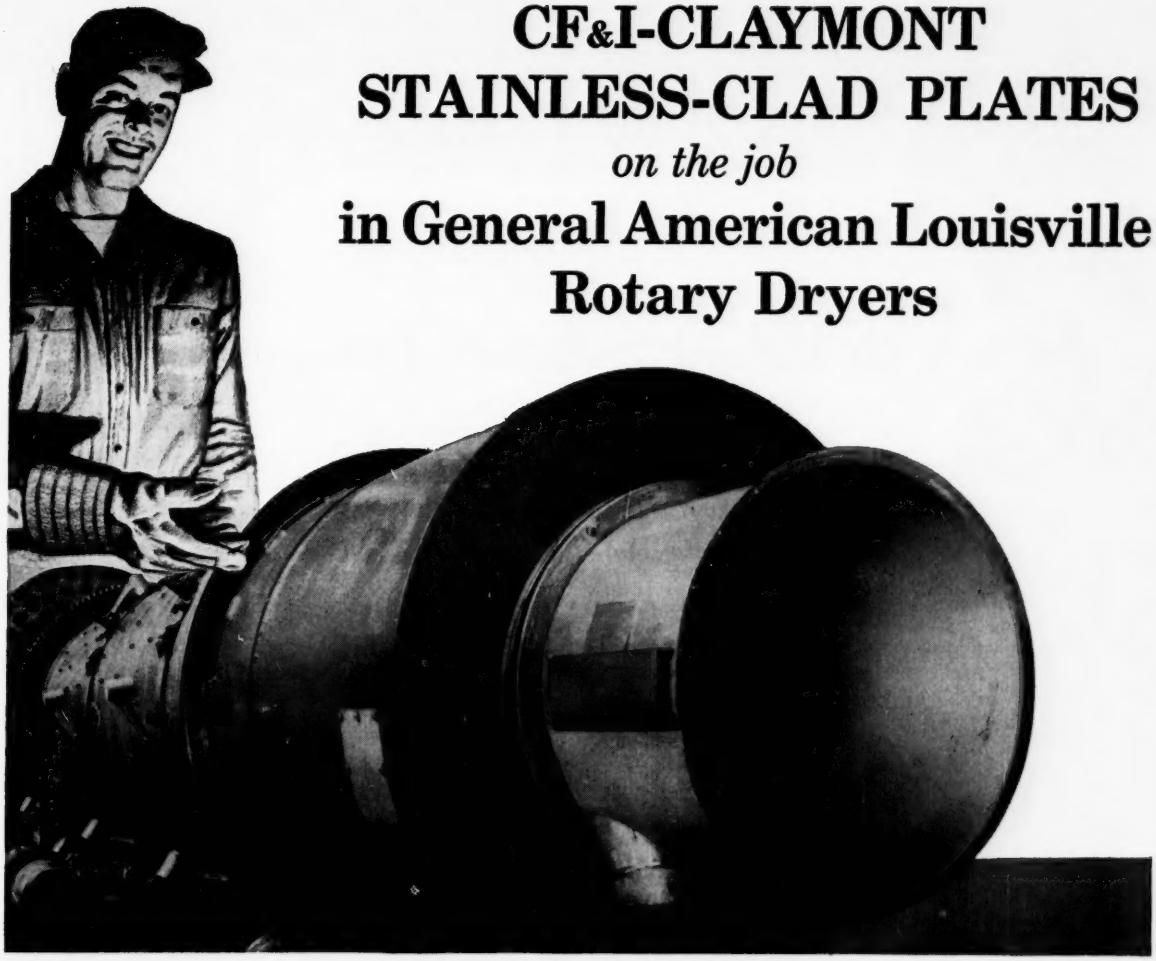
If the estimated repair cost of an old tower is high, evaluate complete replacement. Also consider continued operation of the plant at a minimum loss of tower performance while repairs are in progress.

This article is based on a paper titled "Water Treatment and Cooling Tower Maintenance" presented to the Pet. Div. of the ASME in Houston, Sept. 20-23, 1959.

CF&I-CLAYMONT STAINLESS-CLAD PLATES

on the job

in General American Louisville Rotary Dryers



This warm air dryer, built by the Louisville Dryer Division of General American Transportation Corporation, was fabricated from Claymont Stainless-Clad Steel Plates. The plates consist of a ¼" thick cladding of type 304 stainless, bonded to a 1" plate of flange-quality carbon steel.

The Image of CF&I reflects *customer satisfaction*. For instance, here's what one steel plate user says about a CF&I product made to meet his company's requirements:

"By using Claymont Stainless-Clad Steel Plate, we get the same protection afforded by stainless steel, plus the economies of carbon steel."

This statement was made by Mr. C. F. Spencer, sales engineer for the Louisville Dryer Division of General American Transportation Corporation. He goes on to say, "When dryer specifications require the elimination of corrosion-susceptible metals, or when engineers must provide protection against certain abrasive materials inside the drum, Claymont Stainless-Clad Plates are frequently specified."

In the manufacture of this CF&I-Claymont product, stainless steel claddings—in thicknesses from 5% to 50% of total plate gage—are inseparably bonded to carbon steel backing plates. Claddings are provided to ASTM A-263, A-264 and the following AISI Specifications: 304, 304L, 316, 316L, 316Cb, 321, 347, 405, 410 and 430. We also invite inquiries on other stainless specifications to meet your requirements.

Whatever the job, call Claymont when you're thinking of stainless-clad steel plate. Complete information and prompt service are yours, at the CF&I sales office nearest you.

CF&I-CLAYMONT PRODUCTS: Carbon Steel Plates • Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Clay-Loy High Strength Low Alloy Steel Plates • Flanged and Dished Heads • Pressed Steel Shapes • Manhole Fittings, Covers and Saddles • Fabricated Steel Plate Products • Large Diameter API Pipe

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Metals to Use at Subzero Temperatures

Rapid expansion of low-temperature processing focuses attention on what materials to use. Here is a valuable guide of metals that stand up.

If you're processing a liquid at −300 F., what's the best material of construction to use? Are there any metal problems if the temperature is only −20 or −60 F.?

With low-temperature processing spreading throughout the chemical and petroleum industries, these questions become less academic. Some practical answers are long overdue.

While not providing final answers, Milo Palmer, chief design engineer of J. F. Pritchard, in a talk at a recent ASME meeting,* sheds some light on this neglected area of materials for low-temperature processing. His conclusions are shown in the table.

Actually, low temperatures improve some physical properties of metals. Yield, tensile and fatigue strengths all increase as temperature goes down. But ductility and impact strength (amount of energy absorption before fracture) usually take a nosedive (exceptions are iron, zinc, magnesium).

* ASME Petroleum Conference, Houston, Texas, September 21-23, 1959.

These Metals Stand Up to Low Temperatures

	ASTM Spec.	Relative Cost of Pipe	Maximum Service Temperature, F.
Carbon steel			
Plain	A53 Gr. A	1.00	− 20
Killed (Al)	A106 Gr. A	1.10	− 40
Killed	A333 Gr. C	1.91	− 50
Ferritic alloy			
3½% Ni	A333 Gr. 3	3.33	−150
5% Ni	A333 Gr. 5	3.92	−150
8½% Ni	To A333	5.83	−320
Austenitic alloy			
18 Cr–8 Ni	A312–TP304	8.76	−320
18 Cr–8 Ni	A312–TP316	14.06	−320
18 Cr–8 Ni	A312–TP321	10.10	−320
18 Cr–8 Ni	A312–TP347	12.81	−320
25 Cr–12 Ni	A312–TP309	12.05	−320
25 Cr–20 Ni	A312–TP310	17.09	−320
Nonferrous			
Brass		4.47	−320
Copper		4.59	−320
Aluminum	6061–T6	1.47	−320
Aluminum	3003	1.28	−320
Aluminum	5083	.....	−320

▶ What Is Low Temperature?—Of course, the lower the process temperature, the more severe the material problem. Some form of carbon steel can be used at about −50 F.; below −50 F., expensive alloys or nonferrous metals come into the picture.

It's important to pick materials which stand up to shocks and vibrations. Generally, a minimum Charpy value of 15 ft.-lb. (keyhole notch) is called for at the operating temperature. For severe shock loading, Palmer recommends 20 ft.-lb. or above.

In the range of 0 to −20 F., carbon steel meets most requirements, except in severe shock service.

▶ Around −20 F.—But below −20 F., you enter the area where usual steels become hard, brittle and fracture easily. Between −20 and −50 F., "killed" carbon steel does a fairly good job.

In most steelmaking processes, carbon combines with oxygen, producing gases. If the oxygen isn't removed before or during solidification the ingot ends up with entrapped gases. When this steel is used at a temperature below −20 F., the gas pockets can be focal points for brittle failure. A killed steel has a small amount of aluminum added to scavenge the oxygen before casting—it's a relatively homogeneous metal. However, the temperature limit of −50 F. should be

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raised for killed steel, if there's a possibility of severe vibration or shock.

▶ **Fifty Below** — Dipping below −50 F. eliminates all carbon steels. You can still use a ferritic material at −50 to −150 F., but it needs about 3½% nickel for good ductility and impact strength. This steel will show a Charpy strength of 20 to 25 ft.-lb. at −265 F.

Going down into the area of −150 to −320 F. calls for more expensive metals. Stainless, particularly Type 304, is popular here for many applications, including missile fuel tanks and oxygen plant components. It has good tensile strength for pressure units and good ductility at very low temperatures. It's expensive, however, as the table clearly shows, although stainless steel's high strength compensates for this somewhat (thin walls in pressure tanks and vessels).

Brass, copper and aluminum are leading competitors of stainless in the −150 to −320 F. area. And low-carbon 9% Ni steel also stands up to −320F.

▶ **Pitfalls in Table**—Actually, classification of materials as to minimum service temperature is not as cut-and-dry as the table might indicate.

For instance, heat-resistance, surprisingly, is important for many applications. Some nonferrous materials can't take much heat and may rupture in case of fire.

One item not in the table: metal strength. Until high-strength alloys became available, aluminum wasn't getting much low-temperature business. For pressure vessels, low-strength aluminum is about ⅓ as strong as stainless, and about ⅓ as heavy, while costs are the same on a weight basis. So there isn't much to gain in using this type of aluminum. However, the new, strong, Al alloys such as 5083, together with good welding techniques, paint a bright future for aluminum in low-temperature processing.

Low strength has also kept copper from making much of a dent in subzero equipment, except where it's excellent thermal conductivity is important. Alloying with about 3½% silicon doubles the tensile strength of copper, but cuts thermal conductivity down by a ratio of 8½ to 1.

▶ **Gaskets, Insulation** — While proper metals for piping, valves and vessels are of prime importance, low temperatures also present problems in gaskets and insulation.

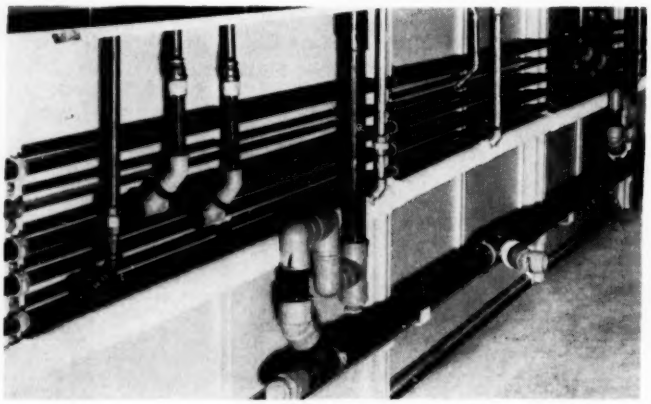
Compressed asbestos, metal, metal-jacketed or spiral-wound metal have all been used. Compressed-asbestos gaskets tend to become brittle at low temperatures. Palmer doesn't recommend them below −20 F.

Aluminum, copper, austenitic-stainless gaskets are all good to −320 F. Fluorocarbon gaskets (Teflon, Kel-F) have been recommended for service to −260 F.

As for insulation, the choice isn't too limited. Perlite, balsa wood, cellular glass, mineral wool and vegetable cork can all be used. Perlite is generally found in steel tank insulation.

▶ **Welding No Cinch** — Aside from the straight material selection problems, low temperatures pose some tough welding situations. Dissolved gases must be minimized in a weld by using low-hydrogen, coated electrodes or submerged arc welding. Also, welding of ferritic-based materials with austenitic electrodes will usually result in a brittle structure in the fusion zone. Some relief from this can be found by using Type 310 electrodes. Palmer also recommends annealing of welds, where possible, for grain refinement.

The problem of joining aluminum to other metals has received a lot of attention. Some of the techniques available include copper-plated aluminum to stainless, tinned aluminum to stainless, aluminum to copper to stainless.

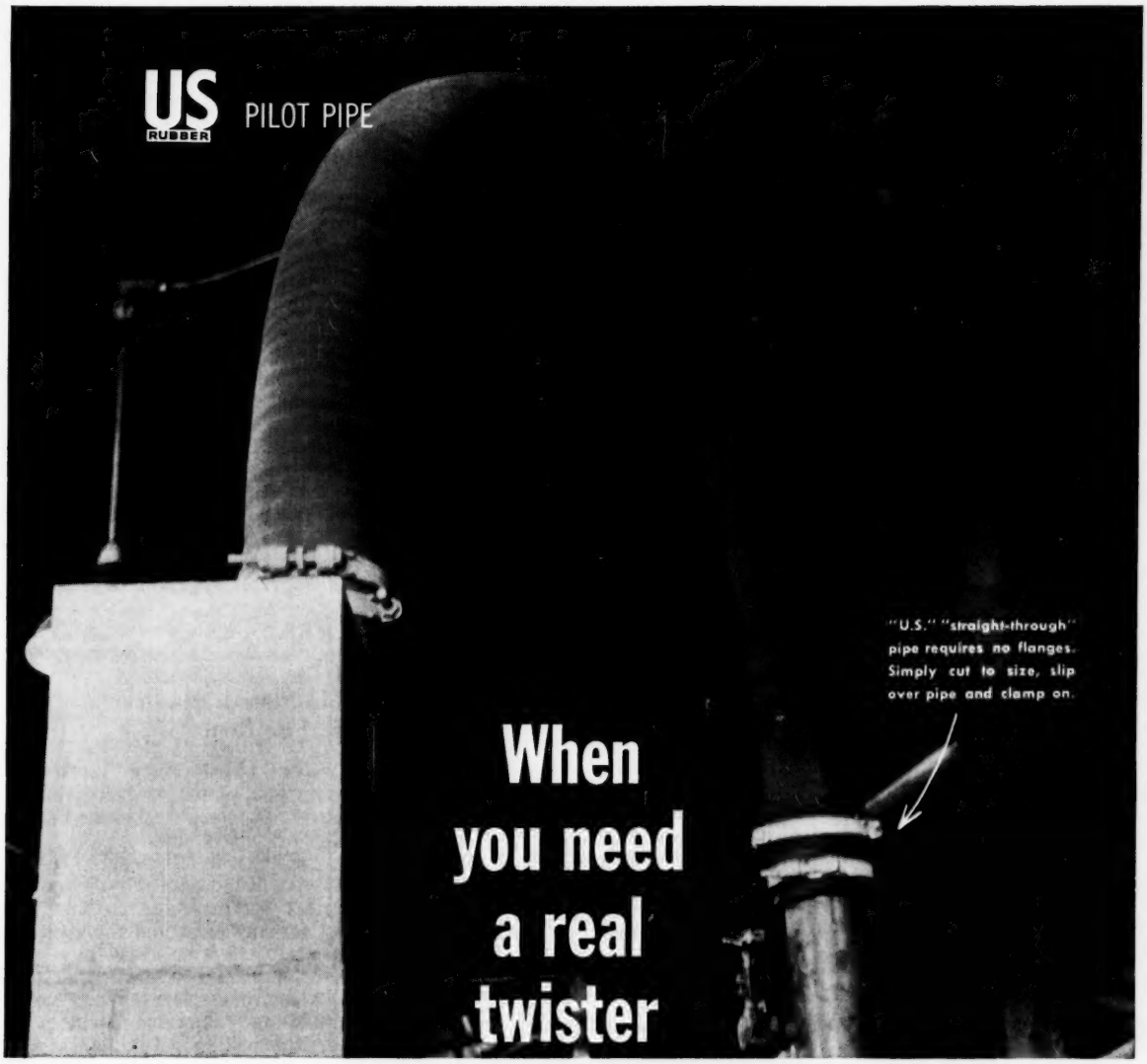


10,000 Ft. of Plastic Pipe Handles Chemical Variety

One of the largest single interior networks of plastic pipe has been installed in Republic Steel's new $5-million research center near Cleveland.

The network consists of over 10,000 ft. of 2-in. dia. low-pressure air lines, vacuum lines and 4-in. dia. vent stacks. Plastic is an acrylonitrile-butadiene-styrene formulation (ABS). Entire installation costs less and was completed in half the time of conventional metal pipe. Material was cut with an ordinary hand saw and joined by solvent welding (no threading).

The ABS plastic handles acids and alkalis; conveys distilled water and other reagents.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"U.S." "straight-through" pipe requires no flanges. Simply cut to size, slip over pipe and clamp on.
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This limber, highly abrasive-resistant U. S. Pilot® Pipe is at work 7 days a week, 24 hours a day (during the 6-month concentrating season) in the heavy media department of the beneficiation plant of a large iron ore producer. It carries 200 gallons per minute of ferro silicon into a magnetic separator.

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- Company records show that U. S. Pilot Pipe lasts about 12 times longer than metal pipe.
- Maintenance is nil.
- Pilot Pipe is so flexible it permits an easily formed angle, eliminating need for elbows (the smooth flow reduces points of turbulence) hence it takes up less room, requires less plumbing.

U. S. Pilot Pipe includes a wide range of designs ("straight-through", duck and rubber flanges, swivel flanges) that handle a wide range of working pressures—from 25 to 250 pounds—and also handle a wide range of chemicals and abrasives.

• • •

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Culprit in Stainless Failures

Recent work reveals how carbon causes stainless to fail in molten sodium service.

Stainless steel, when applied incorrectly, is prone to a great many forms of corrosive attack. One of the most serious at high temperatures: carburization.

Carburization (absorption of carbon by stainless) radically changes steel's strength and corrosion resistance. In many situations, carbon is present in very small quantities, usually as a contaminant.

Work recently completed by GE's E. G. Brush (Knolls Atomic Power Laboratory) gives an insight into this serious problem.

▶ **Carbon Damages Steel**—This work has immediate practical value. For instance, sodium, a good heat-transfer liquid, can easily contain enough carbon to do serious damage.

Actually, austenitic stainless steels are essentially free of corrosion in pure sodium at about 1,000 F. The troublemaker is contaminating carbon.

The GE work, based on exposing Type 347 stainless to molten sodium containing various amounts of carbon, shows no evidence of grain boundary carbide precipitation in tests at 850 F., although some carbon was absorbed. This was true for carbon contents as high as 0.1%.

At 1,000 F., grain boundary carbide is extensive and there is some bulk carbide precipitation at the steel-sodium interface.

At 1,200 F, there is evidence of heavy bulk and grain boundary precipitation.

How much carbon can be tolerated in sodium depends on a number of factors, including operating temperature of the sodium-stainless system and how much carbon absorption is permissable in the stainless.

▶ **Carbon Limits**—In the GE tests, at 850 F., there was little carbon precipitated in grain boundaries when the sodium contained 0.10% carbon. At 1,000 F., precipitation was heavy at a 0.075% carbon content. At 1,200 F., probably sodium should be essentially free of carbon to avoid carburization.

The work at GE also seems to clear up the question of how carbon diffuses into the steel. There's been some argument as to whether it's by lattice diffusion or via the grain boundaries. GE's preliminary verdict: lattice diffusion.

Actually, carbon diffusing into stainless causes stable chromium carbides in solution to precipitate. This has the effect of removing chromium from solid solution and forming hard, carbide phases. The stainless become brittle, with a relatively low resistance to oxidation.

Grain boundary precipitation also makes stainless susceptible to attack by electrolytes. Carbon combines with chromium, leaving the grain boundaries chromium deficient. This isn't too serious until the equipment is shutdown—electrolytes then attack the grain boundaries.

▶ **GE's Technique**—For anyone interested in duplicating the tests, here is the GE technique:

Rods ¼-in. dia. by 3-in. long, Type 347 stainless steel (Cr 18.66, Ni 10.59, C 0.6, Cb 0.62, Mn 1.57, P 0.02, Si 0.015, CO 0.074, with ground surfaces) constituted the test specimens. These were immersed in stainless steel vessels equipped with stand pipes which acted as diffusion cold traps for oxygen control of the test sodium. The vessels were 5-in. dia., 14-in. high, and were partially filled with sodium, introduced by passage through 5 micron pore size porous metal filters maintained at 300 F. to give an initial oxygen content of 0.01%. Approximately four pounds of sodium were used per test. The test vessels were blanketed with helium, and the diffusion cold traps operating at around 220 F. maintained sodium during the tests at an oxygen level of about 0.003%.

Carbon, in the form of powdered graphite contained in fine mesh nickel baskets, was added, to give desired concentration based upon total sodium content, prior to filling the test vessels with sodium.

Test specimens were removed periodically, cleaned by immersion in ethyl alcohol and sent to the shops, where incremented layers of materials were machined off 2½ in. of the specimen length. Chips were collected and submitted for chemical analysis (Lindberg gasometric for carbon). The remaining ½ in. of the specimens were submitted for metallographic examination.

Gold-Plated Missiles Are For Real

We've heard some stories about "gold-plated" rockets and missiles, but never took them too seriously—until now.

According to Englehard Industries, gold-coated missile and aircraft sections are no joke; they actually exist and for good reasons. Gold is an excellent reflector of infrared radiation.

A solution is sprayed or painted on vulnerable surfaces and, after baking, a 4-millionths-in. thick gold film remains. This is abrasion resistant, and as a highly efficient reflector, reduces rate of heat transfer on engine shrouds, drag-chute containers, tail assemblies and blast shields. Weight added by the film is negligible, of course.

Precious-metal solutions can be applied to metal, porcelain-enamel stainless steel, fiberglass laminates and other heat-resistant materials. Painting and baking gives a good coat, and it's cheaper than electroplating or vacuum deposition. Some planes and missiles protected by gold: F-100, F-101, Redstone, Jupiter and Polaris.

Englehard claims platinum as an infrared reflector is in the experimental stage and use of precious metals for space-age applications should increase rapidly in the not too distant future.

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THE FIRST 100% INORGANIC *SELF-CURING* ZINC COATING.

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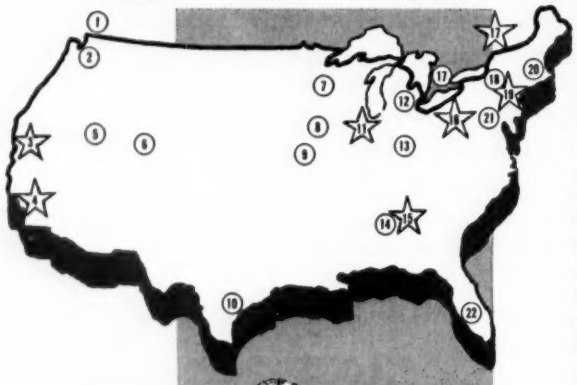

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Versatile DUALAIRE *Jet-Cleaned* Filter Systems

have many advantages for collecting dust from industrial processes. The Dualaire filter tube is cleaned continuously in small increments—not with sudden surges as in jarring or rapping. Pressure drop remains uniformly low... filter efficiencies run as high as 99.99%. No stand-by units are needed—no costly down time for cleaning.

The men shown here are typical of the Dualaire experience available to you—coast to coast—for solving industrial dust problems. Although you may think your particular gas cleaning requirements are unusual, these men have probably solved the same or similar problem for others right in your area.

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FIRMS IN THE NEWS

J. A. KING

NEW FACILITIES

Celanese Engineers View New Acetyl Chemical Plant

Celanese Corporation of America has just completed extensive expansion of its Pampa, Tex. facilities, has increased acetyl chemical capacity to 240-million lbs./yr. Expanded facility is now the largest in the world for acetic acid and acetaldehyde production. New plant's output will be marketed to producers of textile fibers, paints, coatings, synthetic lubricants and insecticides.

California Chemical Co., a subsidiary of Standard Oil Co. of Calif., announces plans for construction of a maleic anhydride plant at Richmond, Calif. New facility, to have a capacity of 10,000 tons/yr., is scheduled for completion by mid-1960.

Cyanamid of Canada, Ltd. is constructing a 190-ton/day nitric acid plant near Niagara Falls, Ont. Cyanamid has contracted Arthur G. McKee & Co., Ltd. to construct the plant by next spring.

Canadian Industries Ltd. has just completed doubling of its polyethylene capacity at Edmonton, Alb. Addition of new capacity began in August, 1957, permits production of 20,000 tons/yr. of polyethylene resin.

Stauffer Chemical Co. has begun construction of a 12,000-ton/yr. liquid alum plant at Vernon, Calif. Growing demand for alum by the pulp and water-purification industries spurred the establishment of new capacity.

Stauffer Chemical Co. an-

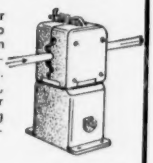
PUMPING IDEAS

POSSIBLE ONLY with a

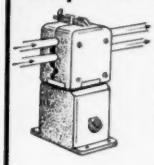
SIGMAMOTOR PUMP

Move Corrosive Liquids

Material being pumped never comes in contact with pump mechanism. Wave-like motion of steel fingers forces material through Tygon tubing. By changing size of tubing, capacity can be increased or decreased. Pump housing opens for removal and insertion of tubing.



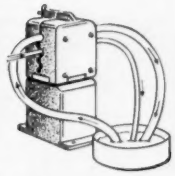
Pump 2 or 3 Different Liquids Simultaneously



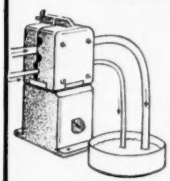
Some models will accommodate up to four tubes so that four different liquids can be passed through the pump at one time without danger of contamination.

Feed and Mix

One or more tubes can be feeding material to a mix while a larger tube is recirculating the liquid to produce agitation and thorough mixing. Viscous materials can be pumped without danger of gumming or plugging. Remove tube and pump is clean.



Meter Additives



One or more additives can be pumped to a solution in the exact amount desired by selecting the correct size of tubing and regulating pump speed. Various controls can be incorporated to close valves ahead of pump.

Capacities from 0.5 cc. per min. to 4.5 G.P.M.

Write for complete information on sizes, capacities.

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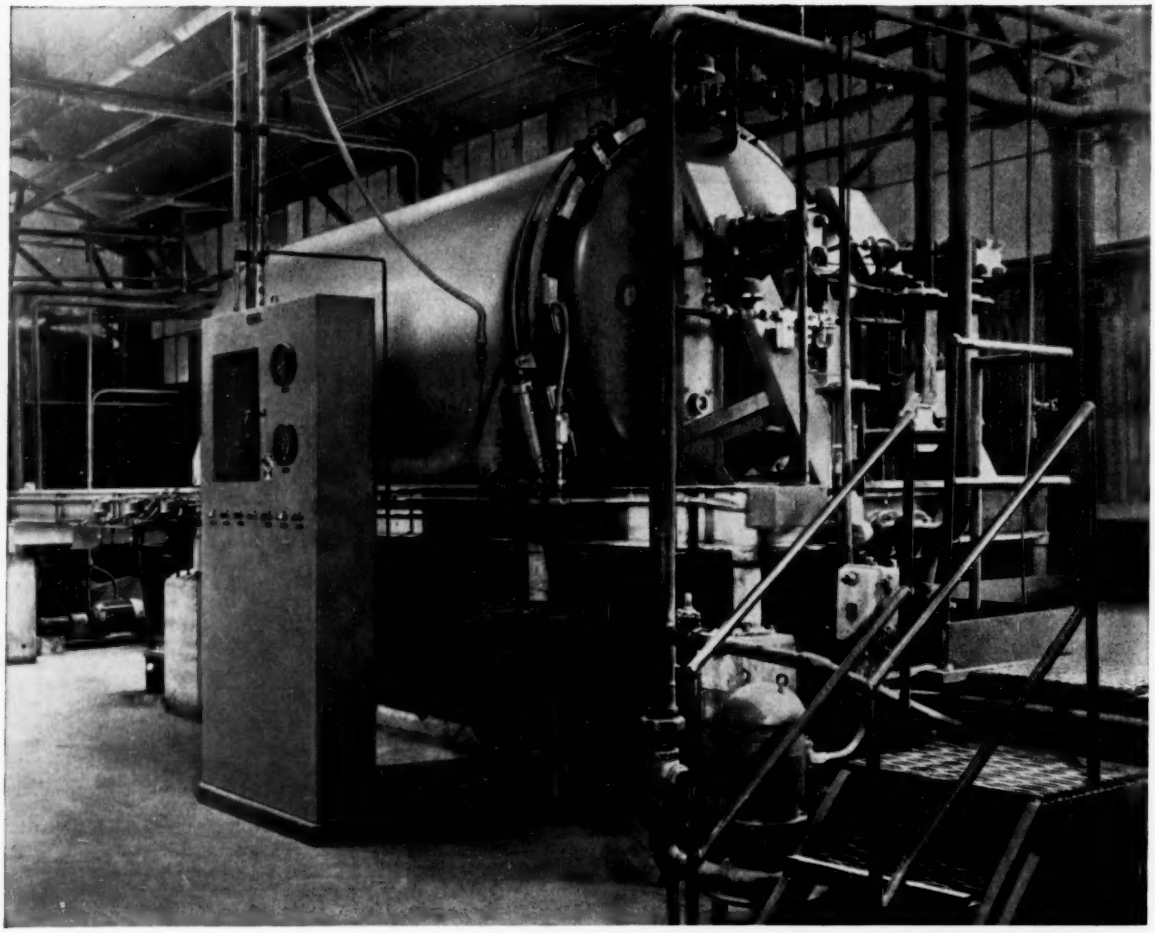

Model MCRS—1120 sq. ft. With Automatic Controls

THIS FILTER OPERATES CONTINUOUSLY UNATTENDED

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FULLY AUTOMATED Model MCRS

This 1120 sq. ft. filter operates itself automatically throughout the entire cycle of precoating, filtering, blowdown and cake discharge; and duplicates the cycle repeatedly, unattended.

The Sparkler exclusive patented plate design, with a free flow, 100% supported mesh, is an important factor in the remarkable efficiency of this large completely automated filter.

Contact your local Sparkler representative or write.

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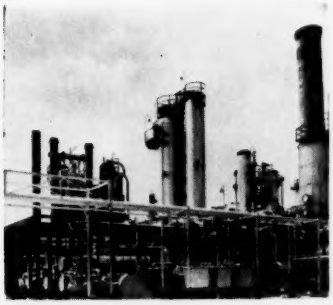
nounces plans for construction of a new p-chlorothiophenol plant at Henderson, Nev. Stauffer also reveals that existing facilities for thiol production at Niagara Falls, N. Y. will be converted for production of other undisclosed chemicals.



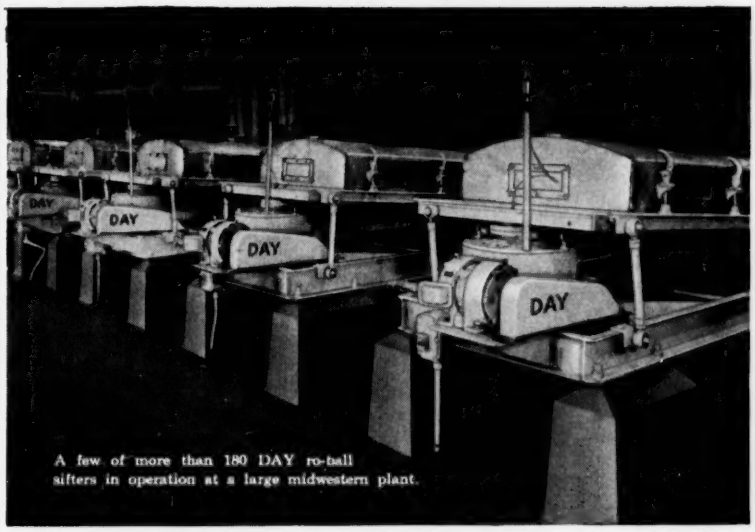
Monsanto Chemical Co.'s Lion Oil Div. has placed on stream its new 5,260-bbl./day deasphalting plant at El Dorado, Ark. New plant (shown above) will employ propane and butane solvents to convert low-grade fuel oil into salable grades of asphalt.

Clintwood Chemical Co. is moving into new facilities in Chicago, Ill. for production of alkanolamides and polyoxyethylene esters. Clintwood markets these specialty chemicals to producers of cosmetics, industrial cleaners, foaming and emulsifying agents.

Pittsburgh Coke & Chemical Corp. is expanding its facilities for production of activated carbon at Neville Island, Pa. Pittsburgh contracted Singmaster & Breyer, Inc., New York, N. Y. to construct the expanison, to cost $800,000.

Arizona Chemical Co. announces plans for construction of a $5-million tall-oil and fatty-acid plant at Springhill, La. Plant will be operated by Arizona Chemical, which is owned by American Cyanamid Co. and International Paper Co.

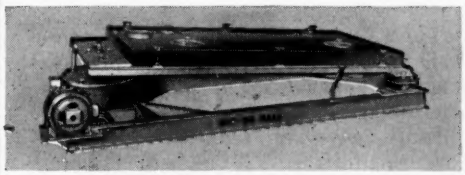
SIFT finer-faster-cleaner with DAY ro-balls



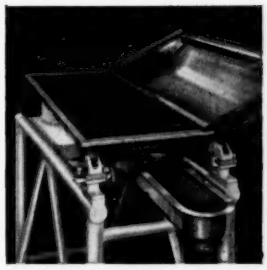
A few of more than 180 DAY ro-ball sifters in operation at a large midwestern plant.

Today thousands of products wet or dry, from flour to wood chips, are sifted through efficient, low-cost, high-production DAY ro-ball sifters. Superbly engineered, built for trouble-free operation under the severest service conditions, they insure longer life with lower maintenance costs.

The exclusive super active ball cleaning device provides rebound points in each ball compartment, assuring fast, thorough sifting of your product. Gyrating action brings material into constant contact with every square inch of screen surface. A stabilizer maintains screen in horizontal position and insures smooth operation.



DAY standard ro-ball, available in six sizes, single or multiple screens. Single screen models in stock.



Stainless steel units available to meet food and dairy sanitary codes.

Many models are available so it is easy to choose one which will exactly suit your requirements. They can be used separately or in combination with DAY mixers or blenders to save product handling. A completely equipped lab is available for testing your product.

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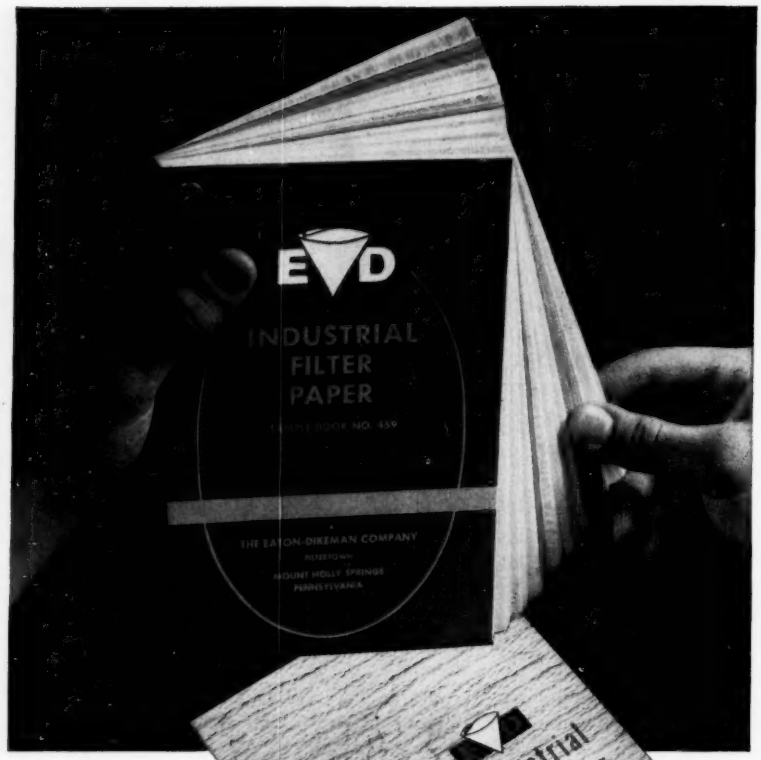

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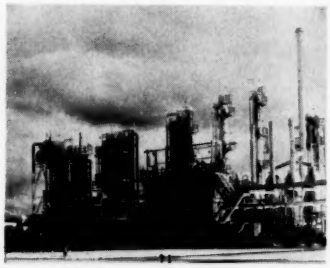
FIRMS . . .

Plastic Horizons, Inc. reveals that its new polyethylene-film plant at Batavia, Ill. is expected to go on stream this month. New facility to produce film and tubing, will make use of modern pneumatic transportation technics for polyethylene-granule handling.



Air Products, Inc. of Allentown, Pa. has placed on stream a large tonnage liquid hydrogen plant near West Palm Beach, Fla. New facility provides liquid hydrogen fuel for rocket-engine tests nearby at Cape Canaveral. The Lummus Co. of New York, N. Y. designed, engineered and constructed the hydrogen production section of the facility shown above.

Borden Chemical Co. plans to place on stream this month its new Illiopolis, Ill. plant for production of polyvinyl acetate, polyvinyl chloride, butadiene-styrene emulsions. Borden's Coatings and Adhesives Dept. will operate the new $500,000 plant.

Buffalo-Eclipse Corp. announces plans to move its Penberthy Mfg. Div. from Detroit, Mich. to expanded modern facilities at Prophetstown, Ill. Penberthy manufactures gages, valves, pumps and ejectors for the chemical industry.

Union Carbide Corp. has formed a new division to expand consumer product sales: Union Carbide Consumer Products Co. New division will market UCC's Prestone and Eveready batteries, as well as other consumer goods.

Bandini Petroleum Co. announces the acquisition of the assets of Long Shot Oil Co., Ltd., crude oil and gas producer of Texas and Oklahoma.

Dow Chemical Co. has made an agreement with Hydrometals, Inc. of Chicago, Ill. for production of a new non-ferrous metal sheet at Dow Metal's Madison, Ill. plant.

Summers Fertilizer Co. anannounces the acquisition of Chemgro, Inc. of Fergus Falls, Minn. Chemgro produces nitrogen-rich and complex fertilizers, employs a 15,000-ton/yr. TVA continuous ammoniator.

Aluminum Company of Canada has shut down its Arvida, Que. magnesium plant indefinitely. Low demands for magnesium in Eastern Canada caused the shutdown of the 4,000-ton/yr. plant.

U.S. Atomic Energy Commission has transferred responsibility for commercial distribution of high-enrichment (up to 92%) boron-10 to its Lockland, Ohio, office. Boron-10 is widely used as a shielding and control material.

Dyna-Therm Chemical Corp. has acquired the assets of Plas-Kem Chemical Corp., Burbank, Calif., producer of vinyl plastisols and organosols. Dyna-Therm produces high-temperature coatings for use in rockets and missiles.

Stauffer Chemical Co. and Kali-Chemie A. G. have established

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CHEMICALS
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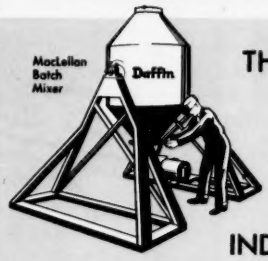
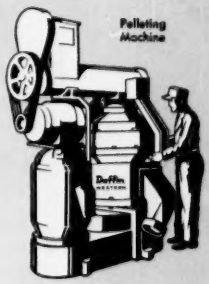
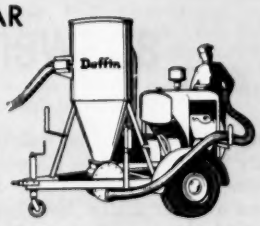


THE EXCELLENCE OF THESE MACHINES HAS BEEN PROVEN IN OTHER INDUSTRIAL FIELDS FOR **GRINDING, MIXING, BLENDING, PELLETING** AND **PNEUMATIC CONVEYING.**



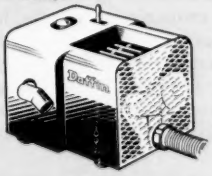
Packaged plant grinds, mixes, blends.

NOW THEY ARE BEING OFFERED TO DO SIMILAR CHEMICAL JOBS . . . EASIER, FASTER, AT LESS COST!



Two-way
Pneumatic
Conveyor

One-way
Pneumatic
Conveyor



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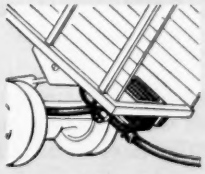
Installation by Factory Engineers. 24 Service-Parts Depots strategically located.


Pneumatic Bulk Truck Unloader

All units also available in stainless steel construction.

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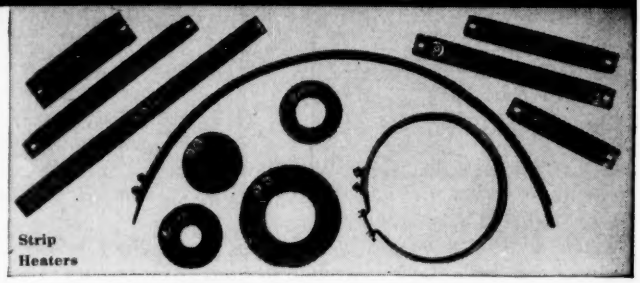
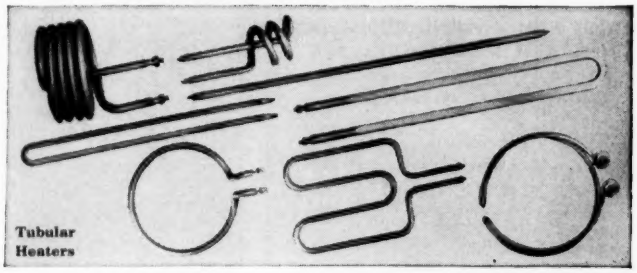
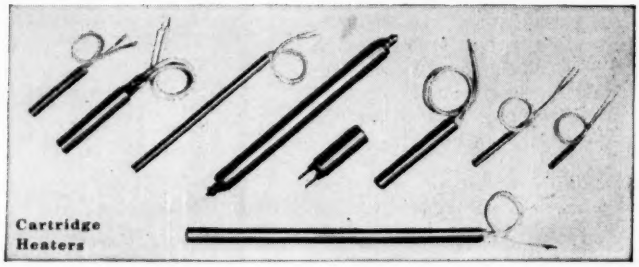
Call your CHROMALOX Man for the heating answers







These 3 basic CHROMALOX heaters provide answers to just about any heating problem

Strip Heaters . . . that quickly and easily bolt or clamp to platens, dies, kettles, tanks, pipes, rolls, drums, ovens and air ducts. Lengths from 4 to 96 inches, widths from ¾ to 2½ inches, with cross section curving or lengthwise bending. Available with brazed-on fins.

Tubular Heaters . . . that clamp on, fit into machined grooves, cast into metals, immerse in liquids, install in ovens and ducts. Straight lengths or factory-formed to nearly any contour. Lengths from 6 inches to 30 feet. Triangular or round cross section. Available with brazed-on fins.

Cartridge Heaters . . . that smoothly fit standard drilled holes in dies, platens, molds, extrusion and injection barrels. Special leads available for protection against flexing action, abrasion, moisture or vapors. Diameters from ⅜ to 1 19/64 inches, lengths from 1⅝ to 25⅜ inches.

Versatile Chromalox electric heaters are available in sheath materials and wattages to match almost any application to 1100°F. Easy to install, they are fast, clean, safe and economical.

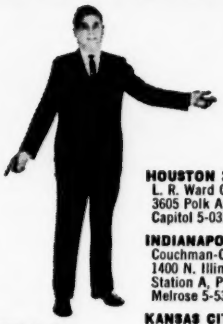
Each has particular advantages. Your Chromalox Man can help you determine the one that best answers your specific problem. He's backed by the world's largest factory stock of industrial heaters, ready for immediate shipment. Why not give him a call. You'll find his phone number listed at the right.

Our new Catalog 60 provides detailed product information and suggests numerous applications for the complete line of Chromalox electric heaters for industry. If you have not yet received a copy, please let us know. 7760

CHROMALOX
Electric Heat
INDUSTRIAL • COMMERCIAL • RESIDENTIAL
EDWIN L. WIEGAND COMPANY
7514 Thomas Boulevard • Pittsburgh 8, Pa.

CHROMALOX

Sales-Engineering Representatives



ATLANTA 9, GA.
Applebee-Church, Inc.
1389 Peachtree St., N.E.
Trinity 5-7244

BALA-CYNWYD, PA.
J. V. Calhoun Company
349 Montgomery Ave.
Mohawk 4-6113
Greenwood 3-4477

BALTIMORE 18, MD.
Paul V. Renoff Company
333 East 25th St.
Hopkins 7-3280

BINGHAMTON, N. Y.
R. P. Smith Co., Inc.
94 Henry St.
Raymond 4-7703

BLOOMFIELD, N. J.
R. L. Faber & Assoc., Inc.
1246 Broad St.
Edison 8-6900
New York: Worth 4-2990

BOSTON 11, MASS.
Leo C. Pelkus & Co., Inc.
683 Atlantic Ave.
Liberty 2-1941

BUFFALO 2, N. Y.
Niagara Electric Sales Co.
505 Delaware Ave.
Summer 4000

CHARLOTTE 2, N. C.
Ranson, Wallace & Co.
116½ E. Fourth St.
Edison 4-4244
Franklin 5-1044

CHATTANOOGA 1, TENN.
H. R. Miles & Associates
P. O. Box 172
Amherst 5-3862

CHICAGO 5, ILL.
Fred I. Tourtelot Company
407 S. Dearborn St.
Harrison 7-5464

CINCINNATI 8, OHIO
The Smysor Company
1046 Delta Ave.
Trinity 1-0605

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J. J. Galleher
617-A Cleveland St.
P. O. Box 1376
Phone 3-7706

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Prospect 1-7112

DALLAS 26, TEX.
L. R. Ward Company
3009 Canton St.
Riverside 1-9004

DAVENPORT, IOWA
Volco Company
215 Kahl Building
Phone: 6-5233

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E. & M. Equipment Co.
2415 Fifteenth St.
Glendale 5-3651
Genesee 3-0821

DES MOINES 14, IOWA
Midwest Equipment Co.
of Iowa
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Cherry 3-1203

DETROIT 38, MICH.
Carman Adams, Inc.
15760 James Couzens Hy.
University 3-9100

HOUSTON 3, TEX.
L. R. Ward Company
3605 Polk Ave.
Capitol 5-0356

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Couchman-Conant, Inc.
1400 N. Illinois St.
Station A, P. O. Box 88023
Melrose 5-5313

KANSAS CITY 6, MO.
Fraser D. Moore Co.
106 E. 14th St.
Victor 2-3306

LOS ANGELES 15, CAL.
Montgomery Brothers
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Richmond 7-5191

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S. Main St. Extension
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Diamond 6-9606

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Gordon Hatch Co., Inc.
531 W. Wisconsin Ave.
Broadway 1-3021

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Volco Company
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Federal 6-3373

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H. R. Miles and Associates
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Cypress 2-7016

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See "Bloomfield, N. J."

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Midwest Equipment Co.
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Atlantic 7600

PHILADELPHIA, PA.
See "Bala-Cynwyd, Pa."

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Woessner-McKnight Co.
1310 Highland Building
115 S. Highland Ave.
Emerson 1-2900

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Capitol 3-4197

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Atlantic 8-8758

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Hamilton 6-2070

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C. B. Fall Company
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Suite 1001
Chestnut 1-2433

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Montgomery Brothers
1122 Howard St.
Underhill 1-3527

SEATTLE 4, WASH.
Montgomery Brothers
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Main 4-7297

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R. P. Smith Co., Inc.
2507 James St.
Howard 3-2748

WICHITA 2, KAN.
Fraser D. Moore Co.
695 Geo. Washington Blvd.
Amherst 2-5647

EXPORT DEPARTMENT
1010 Schaff Building
Philadelphia 2, Pa.

FIRMS . . .

a joint company to produce and market insoluble sulfur in Western Europe. New company, Kali-Chemie-Stauffer G.m.b.H., plans to build a plant at Hanover, Germany to go on stream by early next year.

Metal & Thermit Corporation has formed a Metals and Minerals Div. for research, production, sales and technical service of metals and minerals. New division will also operate mining facilities at Cartaret, N. J.

Simpson Paper Co. of Everett, Wash. is merging with Lee Paper Co. of Vicksburg, Mich.; New Simpson-Lee Paper Co. will continue to supply the formerly separate companies' markets.

Speer Carbon Co., St. Marys, Penn., is purchasing the Electronics Division of Onondaga Pottery Co. of Syracuse, N. Y. The acquisition will give Spear a firmer hold on the ceramics field, related to the electronics industry.

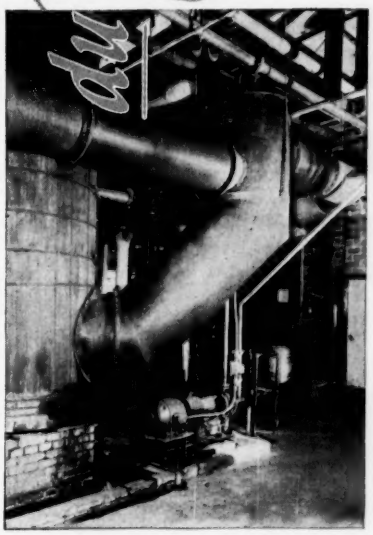
Reichhold Chemicals, Inc. continues its move toward foreign markets, has purchased back its interests in Beckacite Resin, Ltd.; the latter has been converted into the stock company, Reichhold-Beckacite A. G.

OVERSEAS BRIEFS

Austria: Vienna Polytechnicum is adding a 100-mw. reactor to its Nuclear Research and Training Center. New research center to cost more than $2-million, is expected to open by the end of next year.

Amsterdam: B. F. Goodrich Chemical Co. has established a central European sales office at The Hague. New office

du Verre CORROSION REPORT



DU VERRE RESIN BONDED FIBER GLASS EQUIPMENT SOLVES A TOUGH CORROSION PROBLEM!

This 36" diameter du Verre vent assembly installed in a large Eastern chemical plant, replaced a rubber lined duct which failed after only one year's service. Prior to the rubber lined duct, a stainless steel unit failed after only a few months' service. The du Verre duct has been in continuous service for over four years, and shows no signs of corrosion. It has been handling gases containing HBr, HCl, Chlorbenzine and other organic solvents. Since du Verre resin bonded fiber glass is homogeneous in structure, external corrosion which was a problem with the other forms of construction, is entirely eliminated.

du Verre offers a wide variety of resin formulations to provide complete protection under almost any condition . . .

- **#11 offers good acid and solvent resistance at a moderate cost.**
- **#22 is a fire retardant resin with superior corrosion resistance.**
- **#77 is a premium grade resin with excellent corrosion resistance at temperatures up to 300°F.**
- **#101 is a furfuryl alcohol resin which has good resistance to alkali solvents and many acids.**
- **In addition, special resin formulations, including epoxies, ar available for special applications.**

Learn how du Verre can solve your corrosion and contamination problems. Write today for your free copy of Bulletin No. 100.

du Verre

See Us At The Chemical Show Booth 391

duVerre, Incorporated

Box No. 37-A • Arcade, N. Y.

new KENNAMETAL* grades K601 and K701 for corrosion/wear applications

Supplementing K501, a platinum-bonded tungsten carbide that has been giving outstanding service for more than a decade, Kennametal now offers THREE grades to meet a broader range of corrosion/wear requirements.

New K601, a binderless carbide of tantalum and tungsten . . . has less corrosion resistance than platinum bonded K501, but provides superior wear resistance, and costs less. Minimum density—15.3 g/cc with 94.5 Rockwell A hardness. Transverse rupture strength —100,000 psi.

New K701 has been developed for applications where corrosion is less severe, but where "standard" carbides do not have sufficient resistance against corrosive agents. For these conditions, K701 offers a price advantage over both K501 and K601. Minimum density —14.0 g/cc with 92.0 Rockwell A hardness. Transverse rupture strength—150,000 psi. Experimental applications include valve parts, nozzles, catalyst compacting dies, balls and seats, coal processing wear parts.

K501 provides maximum resistance to corrosion where abrasion is a problem. For example, after five days in boiling 5% HNO_3 and 5% H_2SO_4, a test sample showed no measurable weight loss. In boiling 5% HCL, loss was only 74 mg/dm/day. Minimum density—15.1 g/cc with 91.0 Rockwell A hardness. Transverse rupture strength—125,000 psi. Typical application: Seal rings in pumps handling red fuming nitric acid.

If you have corrosion and wear problems with component parts . . . chances are one of these three grades can provide the answer. We will gladly help you select the one that offers the best and most economical solution. Write KENNAMETAL INC., Latrobe, Pa.

*Trademark 97228

INDUSTRY AND KENNAMETAL ...Partners in Progress

FIRMS . . .

is headquarters for sale of plastics, special-purpose rubber and chemicals.

Chile: Schering Compania Limitada has just dedicated its new pharmaceutical plant at Santiago, Chile. Both research and production work will be carried out at the new location.

India: Merck, Sharpe & Dohme is building a plant to produce cortisone and vitamin B-12, will be part of an $8-million pharmaceutical-producing program in India. Starting material for the cortisone process is the indigenous plant Dioscorea deltoidea, which grows wild in Kashmir and Punjab.

Italy: Montecatini has placed on stream a 30,000-metric-ton/yr. ethylene plant at Ferrara, Italy. New facility, engineered by M. W. Kellogg of New York, N. Y. will also produce as much as 15,000 metric tons/yr. of propylene via pyrolysis of heavy naphtha.

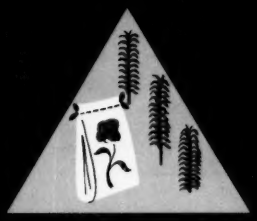
India: Burmah Oil Co. has awarded a $5.6-million contract to Stewart Alloyds to supply 270 miles of 16-in.-dia, steel pipe for construction of an oil pipeline in Assam. Pipeline will run from the Naharkatiya oilfields to a refinery, to be built near Gauhati, Assam.

Hungary's state import agency has contracted with three West German and French firms to deliver petrochemical producing equipment to Hungarian enterprises. Included in the contracts are equipment for a $250,000 argon plant, a 6,000-metric-ton/yr. polyvinyl-chloride plant and a 150,000-cu. m./day natural-gas refinery.

India: Newly formed Cellulose Products of India reveals plans for construction of a 1,200-ton/yr. cotton cellulose pulp and a sodium carboxy methoxy cellulose plant. New facility, to cost $1-million, is scheduled to go onstream by the middle of next year.

PROCTOR

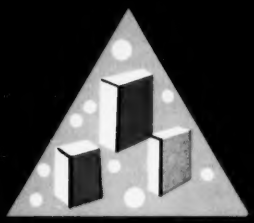
spray dryers

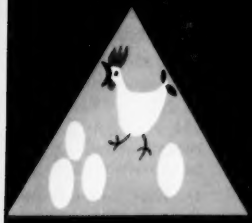


Continuous Automatic Production of the World's Finest Products

PILOT PLANT SPRAY DRYERS

TEST SPRAY DRYING FACILITIES





Write for Bulletin 442

PROCTOR & SCHWARTZ, INC. 7TH STREET AND TABOR ROAD, PHILADELPHIA 20, PENNSYLVANIA

Proctor

COOPER ALLOY VALVE BRIEFS

THE VALVE AND FITTINGS ANSWER CORNER

Send in your questions on stainless valves and fittings to Carl Tylka, Cooper Alloy Technical Service Director.

Q. *What is meant by "ferroxyl quality" in evaluation of a stainless casting?*

A. This means a superior surface quality free from pinholes, porosity, scale particles, iron film, grease, or other undesirable conditions, as is guaranteed by passing the ferroxyl test.

Q. *Will stainless steel of the 18-8 type corrode in a moist atmosphere?*

A. Not ordinarily, but it will in contact with graphite.

Q. *Can the use of stainless materials having different hardnesses be effective in preventing galling?*

A. Yes, providing the hardness differential amounts to 50 Brinell or more. Corrosion resistance of the hardened material is generally lowered, however, and trouble may ensue in severe service. Use of V2B alloy as the hardened medium will prevent galling and provide sufficient corrosion resistance.

Q. *Is 18-8s MO (316) better than 18-8s (304) for use in hot strong nitric acid?*

A. No, in this particular case 304 is better than 316.

Q. *Why is it that steel is resistant to 70% sulfuric acid, while stainless 304 is not?*

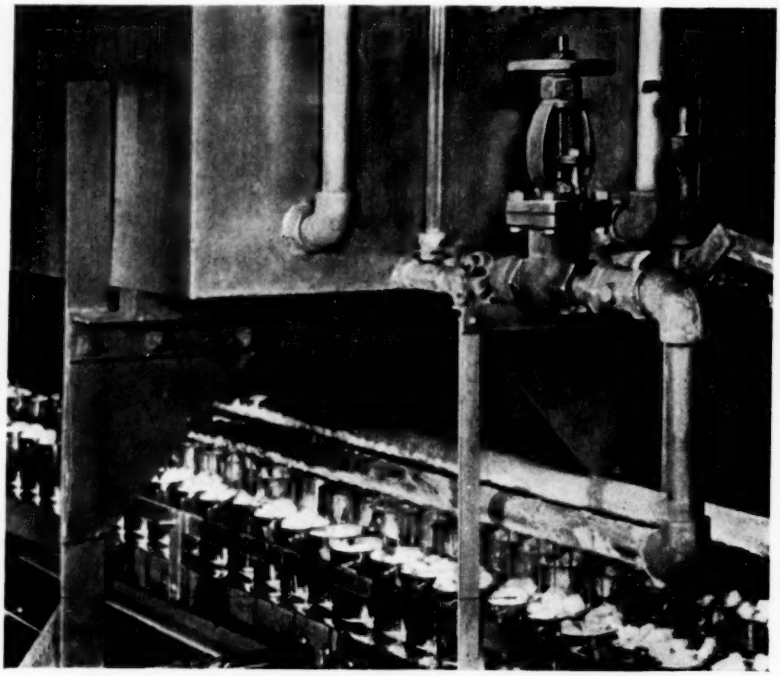
A. Because sulfuric acid forms an iron sulfate film on carbon steel which is insoluble in sulfuric acid of over 65% concentration, thus protecting the steel from further corrosion. This particular film does not form on stainless, which depends upon passivity for corrosion resistance. In 70% sulfuric acid passivity is lost and the stainless corrodes.

Q. *Is 316 alloy better than 304 for handling hot caustic solutions?*

A. No, 316 has no better resistance than 304 and FA-20. That is why Monel is recommended. In extremely severe cases use pure nickel.

Q. *What can I use where 316 is necessary for corrosion resistance, but fails through lack of resistance to accompanying abrasion or erosion?*

A. Cooper PH-55A alloy resists all corrosive media that can be handled by 316 (except very hot and strong nitric acid), and in addition is resistant to both abrasion and erosion.



How the Cooper Alloy Valve became a Giant—among Shrimps!

Cooper Alloy Valve Handles Hot Brine at Shrimp Canning Plant for Twelve Years Without Maintenance

It's not often that we get a chance to put a title as catchy as this on our valve success stories, but this story really rates it!

It all happened at the Robinson Canning Company in New Orleans, one of the world's largest canners of shrimp. They can as much as 100,000 lbs. of shrimp a day—three cans a second! And here's the problem: to the shrimp in each of these cans hot brine solution (180°F.) is added as a preservative—to the shrimps, that is, because brine is mightily corrosive to most valve materials.

The master control valve for this gravity-feed brine-filling operation used to be a brass gate valve, but it couldn't stand the corrosion gaff. So, 12 years ago the Robinson people replaced it with a Cooper Alloy 1-in. Monel gate valve. (Vital statistics: OS&Y, 150-lb. service, bolted bonnet, screwed ends.)

And during the ensuing 12-year period, this Cooper Alloy valve has handled 2500 gallons of hot brine per day—without maintenance of any kind! Only very recently did it become necessary to replace a few non-Monel parts, such as handwheel, packing flange, and eyebolts.

As we said at the start of the story, that's a performance record that's a giant in any man's process! For more information on Cooper Alloy valves and their performance capabilities, write to Cooper Alloy Corporation, Hillside, N. J.

CALENDAR

Packaging Specifications Conference, Purdue University.
Oct. 5-6 Lafayette, Ind.

American Gas Assn., national conference, Conrad-Hilton Hotel.
Oct. 5-7 Chicago, Ill.

International Symposium on High-Temperature Technology, arranged by Stanford Research Institute.
Oct. 6-9 Asilomar, Calif.

Society of Plastics Engineers, Technical meeting: Vinyl Plastics.
Oct. 7 Cleveland, Ohio

National Cotton Council of America, annual chemical finishing conference, Mayflower Hotel.
Oct. 7 Washington, D. C.

American Vacuum Society, annual meeting, Penn Sheraton Hotel.
Oct. 7-9 Philadelphia, Pa.

American Ceramic Society, Refractories Division, Bedford Springs Hotel.
Oct. 8-10 Bedford, Pa.

American Society for Testing Materials, Pacific Area National Meeting, Sheraton-Palace Hotel.
Oct. 11-16 San Francisco, Calif.

Assn. of Agricultural Chemists, annual meetings, Shoreham Hotel.
Oct. 12-14 Washington, D. C.

Technical Assn. of the Pulp and Paper Industry, engineering conference, Penn Sheraton Hotel.
Oct. 12-15 Pittsburgh, Pa.

Western Agricultural Chemicals Assn., fall meeting, Villa Hotel
Oct. 13-14 San Mateo, Calif

Society of Plastics Engineers, technical conference, Ambassador Hotel.
Oct 13-14 Los Angeles, Calif.

Natural Gasoline Assn. of America, southern meeting, Carlton Hotel.
Oct. 16 Tyler, Tex.

American Production and Inventory Control Society, annual technical conference and exhibit, Hotel New Yorker.
Oct. 16-17 New York, N. Y.

International Fair of the Plastics Industry, Europe Hall.
Oct. 17-25 Dusseldorf, Germany

American Coke & Coal Chemicals Inst., annual meeting, Greenbrier.
Oct. 19-20 White Sulfur Sp., W. Va.

American Standards Assn., national conference, Sheraton-Cadillac Hotel.
Oct 20-22 Detroit, Mich.

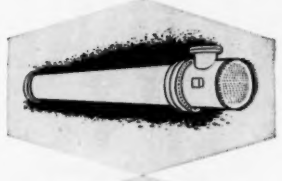
National Agricultural Chemicals Assn., national meeting, Sheraton Hotel.
Oct. 21-23 French Lick, Ind.

American Zinc Institute, Galvinizers Committee meeting, St. Francis Hotel.
Oct. 22-23 Canton, Ohio

Lengthen Condenser and Heat Exchanger Life

John Crane®

Plastic* Tube Protectors

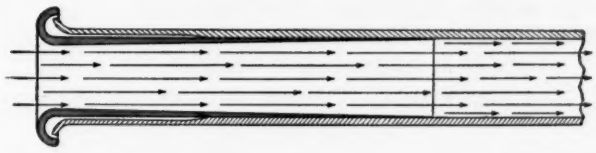


- Protect tube ends for life of tube.
- Positively prevent erosion and abrasion.
- Reduce costly tube maintenance and replacement.
- Easy to install—just slip into tube inlet after coating outer surface with cement.

* Nylon, Polyethylene or Phenolic Resin

PLUS EXCLUSIVE FREE-FLOW DESIGN

Wall thickness gradually tapers toward discharge end. Assures smoothest possible water flow, eliminates turbulence.

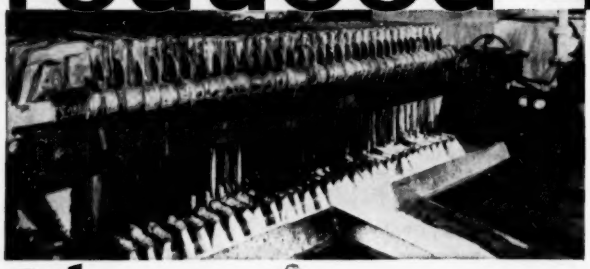


Get the facts. Request new Bulletin P-335.

John Crane® CRANE PACKING COMPANY

6451 Oakton Street, Morton Grove, Illinois (*Chicago Suburb*)
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

annual filter paper costs reduced 41%



at ANACONDA® with NETONE FILTER PAPER

- *Netone has service life of 12 cycles (old paper lasted one cycle)*
- *Easier to put on filter press, less installation damage*
- *Shows excellent resistance to solution shock*

At The Anaconda Company, Electrolytic Zinc Plant, located at Anaconda, Montana, Netone filter paper has been used exclusively on the Shriver filter presses since January 1, 1955. Netone is a heavy, neoprene filled paper possessing remarkable wet strength characteristics.

Prior to the use of the Netone paper on the Shriver presses, it was necessary to discard the kraft paper sheets then in use each time a press was cleaned. The life of the Netone paper in the same service is an average of 12 press cycles. Due to its greater wet strength, the Netone paper is less apt to be damaged during installation and has greater resistance to rupture from solution shock when the press is put in service.

Annual filter paper costs have been reduced 41%. The savings in labor and filter down time are also considerable.

Why not try NETONE Filter Paper on your filter? Test samples on request, no obligation, of course.

Weavers of Industrial Filter Media for over Fifty Years

NFM *The* **NATIONAL FILTER MEDIA** *Corporation*

General Offices and Mills: New Haven 14, Conn.

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Toronto: Lee Benner Chem., C. P. R. Roadway, 1119 Yonge St.
Mexico City: Maquinaria Minera, Apartado Postal #215
Cincinnati, Ohio: Roselawn Center Bldg.
Houston, Texas: 1607 Jefferson Ave.
Pensacola, Fla.: Chem-Quip Co., 2 Texas Drive
Montreal: Lee Benner Chem., 4700 Prince of Wales

CALENDAR

National Lubricating Grease Institute, annual meeting, Roosevelt Hotel.
Oct. 26-28 New Orleans, La.

Independent Petroleum Assn. of America, annual meeting, Statler-Hilton Hotel.
Oct 26-27 Dallas, Tex.

American Institute of Chemical Engineers, New York Section, annual symposium, New Yorker Hotel.
all-day symposium, New Yorker Hotel.
Oct. 27 New York, N. Y.

Society of Aircraft Materials and Process Engineers, Sealant and Sealing Symposium, Institute of Aeronautical Sciences Building.
Oct. 28-30 Los Anegeles, Calif.

Canadian Chemical Specialties Manufacturers Assn., annual meeting and convention, Royal York Hotel.
Nov. 2-4 Toronto, Ont.

Atomic Industrial Forum, annual conference, Sheraton-Park Hotel.
Nov. 2-3 Washington, D. C.

Metallurgical Society, American Institute of Mining, Metallurgical and Petroleum Engineers, National Metal Congress. Morrison Hotel.
Nov. 2-5 Chicago, Ill.

American Society for Metals, annual exposition and congress, International Amphitheatre.
Nov. 2-6 Chicago, Ill.

Technical Assn. of the Pulp and Paper Industry, Alkaline Paper Conference, Robert Meyer Hotel.
Nov. 4-6 Jacksonville, Fla.

Eighth Annual Instrumentation Conference, Louisiana Polytechnic Institute.
Nov. 5-6 Rushton, La.

International Rubber Conference, sponsored by A.S.T.M., A.C.S., and A.S.M.E., Shoreham Hotel.
Nov. 8-13 Washington, D. C.

American Petroleum Institute, 39th annual meeting, Conrad-Hilton, Palmer House and Congress Hotels.
Nov. 9-11 Chicago, Ill.

National Academy of Sciences-National Research Council, construction conference, Shoreham Hotel.
Nov. 16-19 Washington, D. C.

National Assn. of Corrosion Engineers, annual General Florida Conference, Corrosion Short Course.
Nov. 16-20 Miami, Fla.

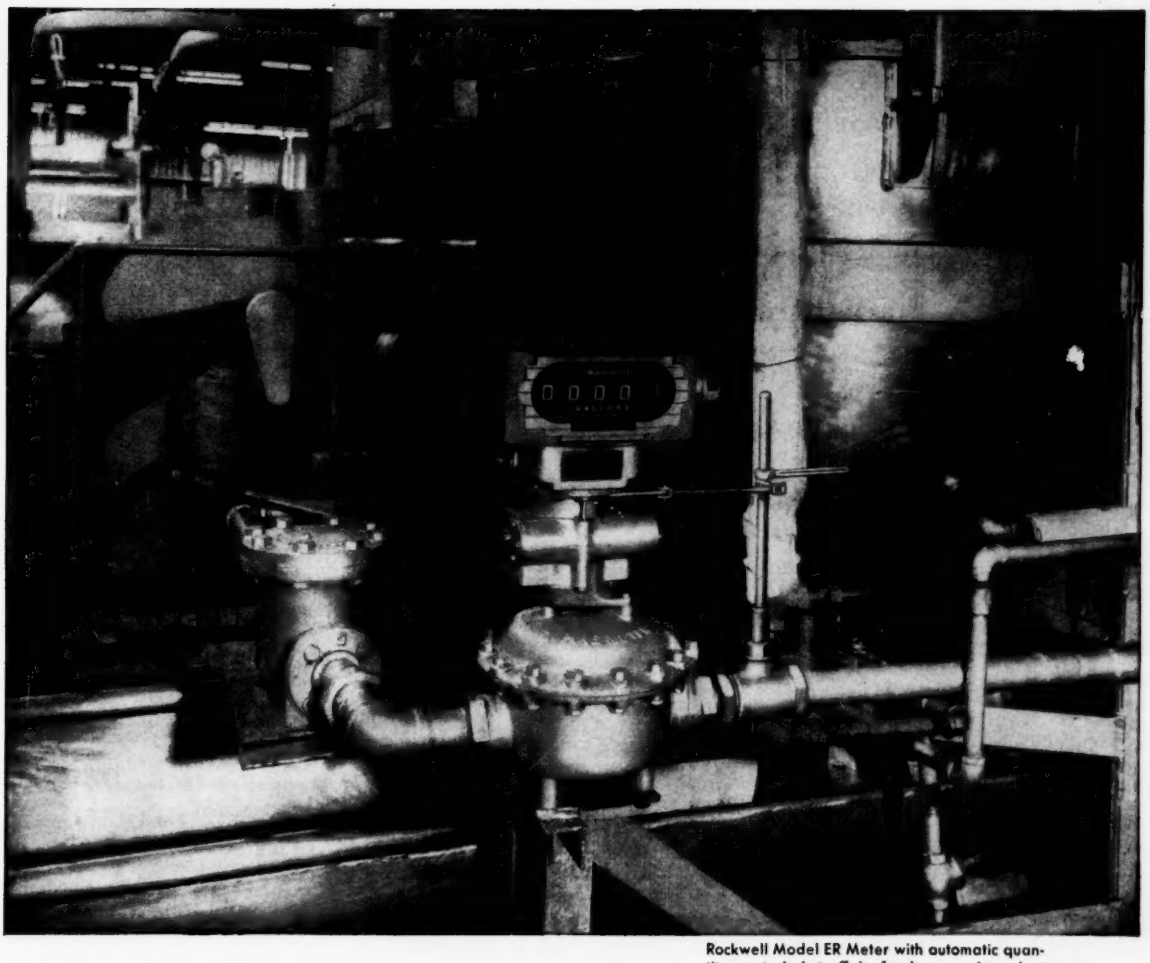
Fifth International Automation Congress and Exposition, Trade Show Building.
Nov. 16-20 New York, N. Y.

American Standards Assn., national conference on standards, Sheraton-Cadillac Hotel.
Nov. 18-20 Detroit, Mich.

Society of Plastics Engineers, Technical conference on Plastics in packaging.
Nov. 19 San Francisco, Calif.

American Nuclear Society, national meeting, Sheraton Park Hotel.
Nov. 4-6 Washington, D. C.

Exposition of Chemical Industries, New York Coliseum.
Nov. 30-Dec. 4 New York, N. Y.



Rockwell Model ER Meter with automatic quantity control shut-off in food processing plant

Batch it, blend it, or just plain account for it!

IT'S GOOD BUSINESS TO METER ALL LIQUIDS

Wherever liquids are stored, mixed or used in plant operations, you can save time, money and improve efficiency with Rockwell industrial meters. With meters you can batch, blend and control formulas with precision. Handling volatile liquids, metering provides the safety of a closed piping system and guards against contamination.

Rockwell industrial meters are valuable accounting tools. Thousands use them for in-plant cost identification purposes, for inventory control—even to guard plant security.

You can measure most any piped liquid with Rockwell meters—oils, liquors, paints, chemical solutions—over 50 liquids in all. Use the coupon for full details.

CLIP COUPON—MAIL TODAY!

INDUSTRIAL METERS

another fine product by

ROCKWELL

ROCKWELL MANUFACTURING CO.
Pittsburgh 8, Pa.

Gentlemen:

I am interested in measuring _____ (Name of Liquid)

Pipe Size _____ "

Working Pressure _____ psi Temperature _____ °F max.

Max. Flow Rate _____ gpm Min. Flow Rate _____ gpm

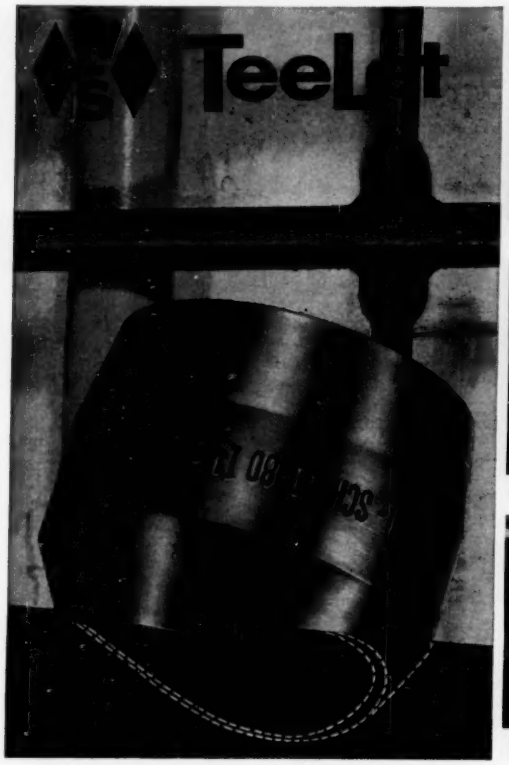
Your Name _____

Company _____

Street _____

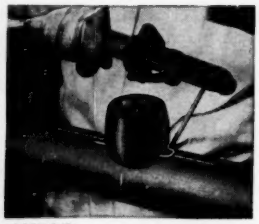
City _____ Zone ____ State _____

FOR ⅛ TO 1½ INCH BRANCH CONNECTIONS



MARK

CUT



WELD

NEW W-S TeeLet SLASHES TEE COSTS 50% OR MORE!

The new W-S TeeLet replaces conventional Tees of cast or malleable iron, welded or forged steel . . . requires fewer stock sizes. Available in sizes from ⅛ to 1½" IPS, TeeLets are fully machined from forging quality solid steel bars and adapt to run-pipe sizes to 36". They require no additional joint strength calculations for any ASTM A-53 or A-106 Grade B run-pipe of Schedule 40 or 80.

What about cost? A size-by-size comparison with conventional Tees shows TeeLets average less than 50 per cent of the cost you now pay. A W-S TeeLet, with screwed, socket-weld or butt-weld ends, requires no shaping, fitting, beveling or extra alignment. You can connect to the run-pipe at any point. Short heights mean easy inspection of the attachment weld or back-weld, if desired.

A W-S TeeLet costs less to buy, less to install than anything you can buy or make. For complete information, prices, and names of distributors, write: *Forge and Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, N. J.*

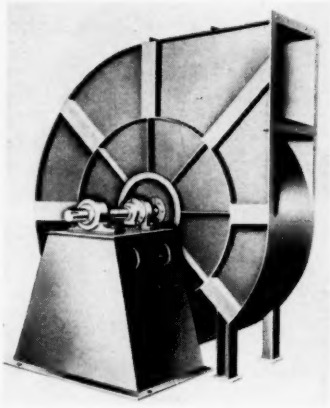
FORGE AND PORTER FITTINGS DIVISION

H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Specialty Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H. K. PORTER COMPANY de MEXICO, S. A.; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

(*Continued from p. 68*)

board. If multiple batches of any one formula are required, the operator then selects the specified number on a preset batch counter.—**Toledo Scale Corp., Toledo, Ohio** **68E**



Pressure Blowers

Feature quiet, power-saving airfoil blading.

High-efficiency, large-capacity pressure blowers equipped with airfoil blading are available in capacities from 8,000 to 64,000 cfm. at pressures from ¾ to 2¼ psig.

While permitting quieter operation, the airfoil blading and aerodynamic flow passages through wheel and housing also give optimum performance with minimum power input. Called the Series 2400, the blowers also feature statically and dynamically balanced wheels that are completely stress-relieved. —**Westinghouse Sturtevant Div., Boston, Mass.** **194A**

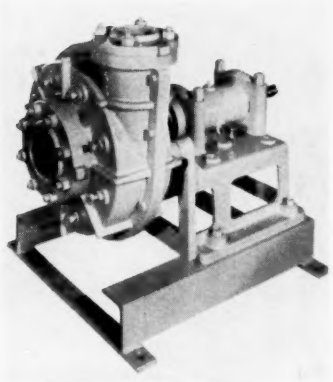
Aluminum Fittings

Are extra long for simplified welding, flanging.

Complete line of aluminum fittings for Schedules 10 and 40 pipe incorporates the extra-length feature familiar to users of Speedline stainless steel fittings. The extra length gives more clearance for welding, simplifies alignment, allows for

flanging without welding and permits a multiple choice of joint at every connection.

Joints may be butt-welded or socket-welded with aligning connectors. Either serrated flanges or unions may be used where demountable joints are required.—**Speedline Div., Horace T. Potts Co., Philadelphia, Pa.** 194B



Ceramic-Lined Pump

Wearing parts last 2 yr. in abrasion service.

Highly resistant to abrasion, the new Model RXA pump will operate as long as two years without major repair to the shell or impeller. Wearing parts are lined with silicon-nitride-bonded silicon carbide. The lining is also resistant to acids.

Pump capacities range from 150 gpm. at 110-ft. head to 600 gpm. at 70 ft. Cost of Model RXA is comparable to alloyed iron or rubber-lined pumps.—**The Kansas City Hay Press Co., Kansas City, Mo.** 195A

Safety Enclosure

Houses fluorine cylinders. Controls are accessible.

A new enclosure for the safe handling of cylinders containing elemental fluorine is available for pilot-plant and laboratory applications. Developed by the General Chemical Div. of Allied Chemical Corp., the unit

SEILON

POLYOLEFINS

SEILON ETH
Regular Polyethylene
(Specific Gravity 0.92)

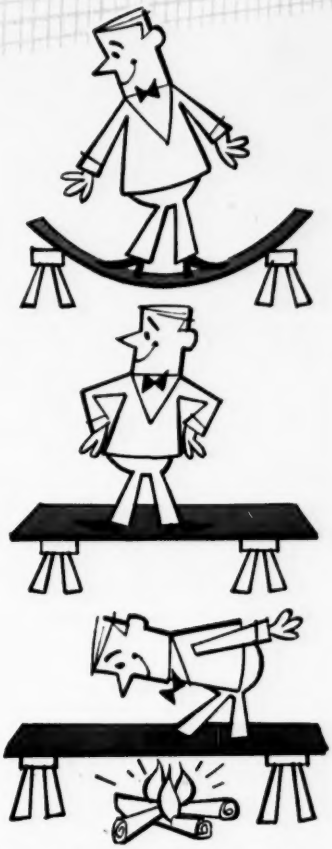
Combines inertness and flexibility over a wide range of temperatures.

SEILON ETH-R
High Density Polyethylene
(Specific Gravity 0.96)

Appreciably stiffer than regular polyethylene. Stiffness and higher heat distortion properties have provided many new production possibilities.

SEILON PRO
Polypropylene
(Specific Gravity 0.90)

High heat distortion (service temperatures up to 300° F), stiffness and inertness to environmental stress cracking have created new horizons for plastic applications.



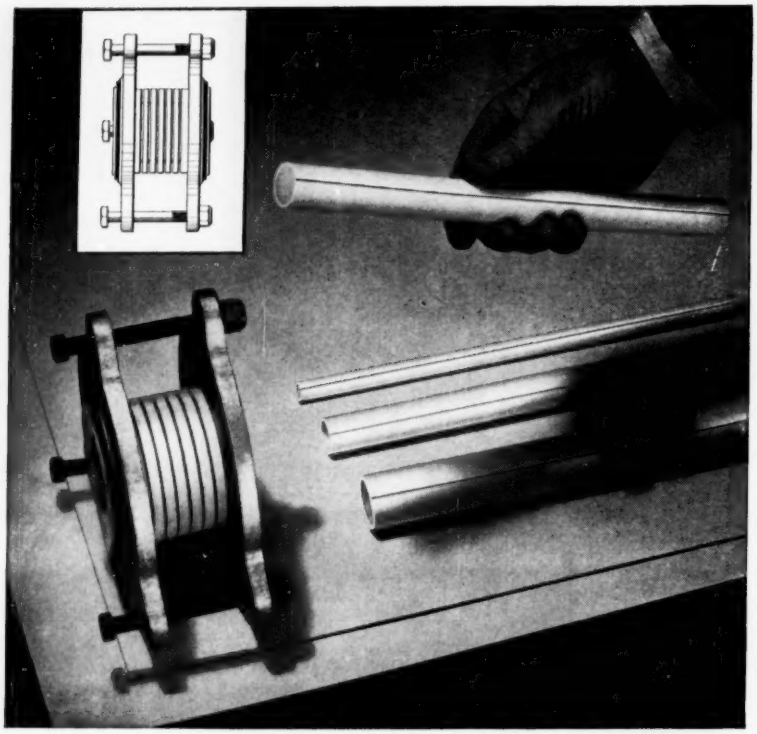
The above materials are available in 48" wide rolls from 0.010" to 0.060" in thickness; also available in 48" x 96" sheets from 0.060" to 1.00" in thickness. We will welcome the opportunity to consult with you on your individual specifications. A letter or a phone call will start us working on your problem.

SEILON

PLASTICS DIVISION
SEIBERLING RUBBER COMPANY
Newcomerstown, Ohio • Phone: HYatt 8-8304

TEFLON* NEWS FROM R/M

- New expansion joint
- Color-striped thin-wall tubing
- Larger sheet sizes



New expansion joint and color striping on thin-wall tubing are part of R/M's comprehensive line of tubes, rods, sheets, tape and bondable "Teflon."

Raybestos-Manhattan announces three important additions to the broadest array of "Teflon" products available to the chemical industry: a new "Teflon" expansion joint featuring square convolutions for additional strength in flexure; "Teflon" thin-wall tubing with color striping to permit ready identification of individual tubes, and 1/32-in.-thick "Teflon" in new 36 x 36 in. sheets. Other thicknesses available in sheets up to 48 x 48 in.

R/M also offers ample facilities for extruding, molding and machining "Teflon" to your exact specifications. In fact, whenever you look to "Teflon" to solve a problem, depend upon R/M to meet your needs. Consult your nearest R/M district office for courteous, competent assistance. For literature, write Plastic Products Division, Manheim, Pa.

*A Du Pont trademark

RM

RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION FACTORIES: MANHEIM, PA.; PARAMOUNT, CALIF.

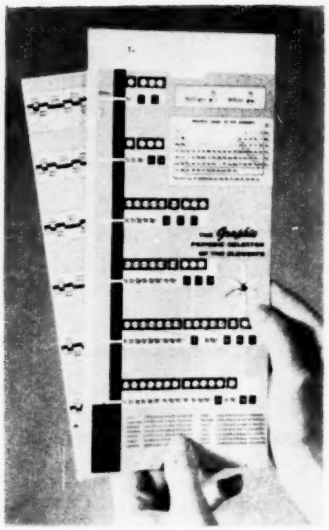
Contact your nearest R/M district office listed below for more information or write to Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

BIRMINGHAM 1 • CHICAGO 31 • CLEVELAND 16 • DALLAS 26 • DENVER 16 • DETROIT 2 • HOUSTON 1
LOS ANGELES 58 • MINNEAPOLIS 16 • NEW ORLEANS 17 • PASSAIC • PHILADELPHIA 3
PITTSBURGH 22 • SAN FRANCISCO 5 • SEATTLE 4 • PETERBOROUGH, ONTARIO, CANADA

RAYBESTOS-MANHATTAN, INC., Engineered Plastics • Asbestos Textiles • Mechanical Packings • Industrial Rubber Sintered Metal Products • Rubber Covered Equipment • Abrasive and Diamond Wheels • Brake Linings Brake Blocks • Clutch Facings • Laundry Pads and Covers • Industrial Adhesives • Bowling Balls

has been thoroughly tested and proved in actual practice.

Each enclosure consists of a steel structure that completely encloses the fluorine cylinder. Controls are provided on the exterior of the enclosure for opening the cylinder valve, metering the gas through two Monel needle valves, and purging the fluorine delivery system with nitrogen. Connections for a 4-in. exhaust duct permit venting of the device. Materials of construction are corrosion resistant.—**Apex Scientific Co., Orinda, Calif.** **195B**



Periodic Selector

Presents most-used data for all chemical elements.

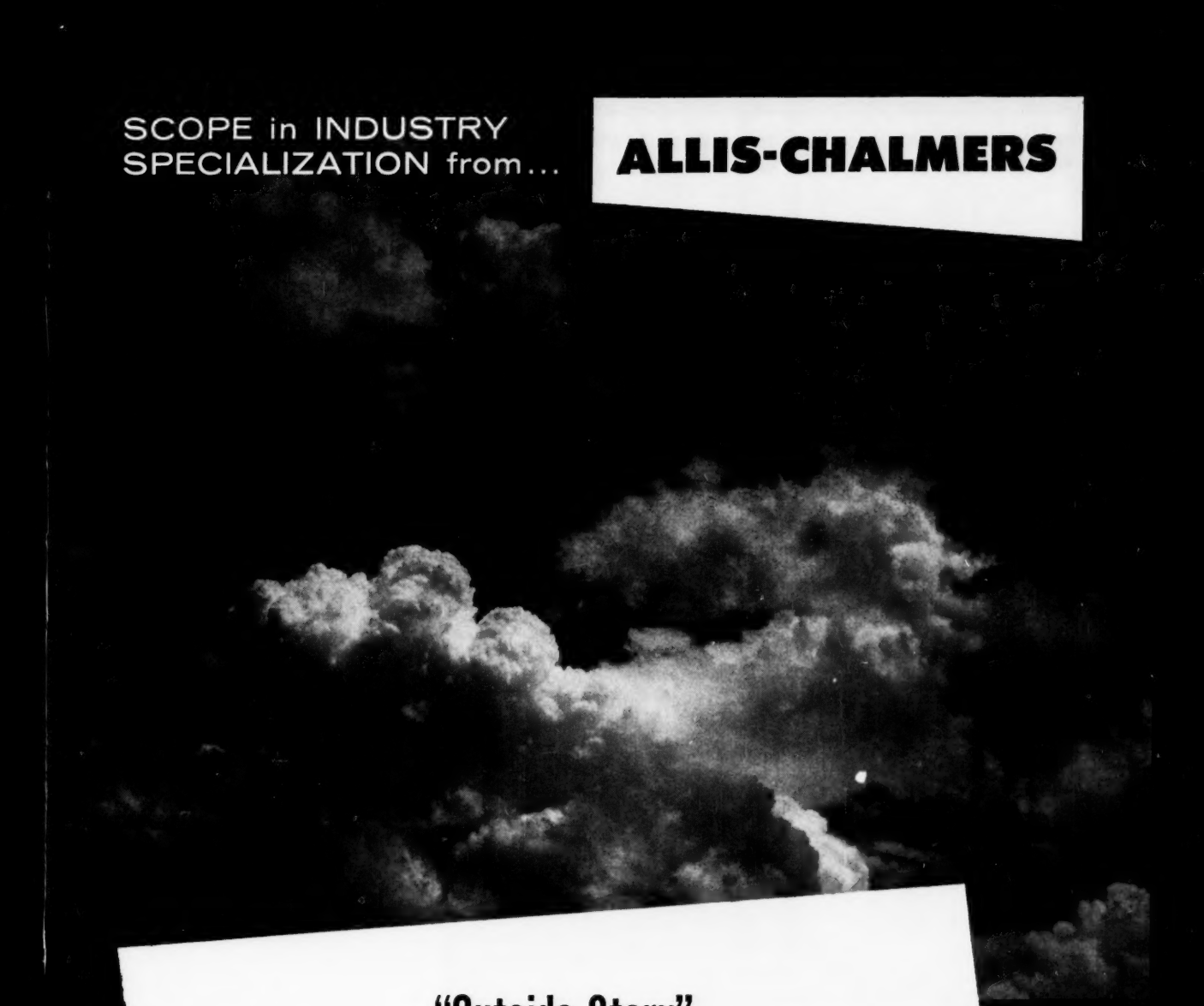
Graphic's new Periodic Selector of the Elements provides a quick and accurate picture of all of the elements in terms of their physical and chemical properties. With this new device, engineers have a handbook of information at their fingertips.

According to the manufacturer, the selector greatly simplifies the understanding of the structure of atoms and significant relationships between the chemical elements. As such, the device should prove quite useful to students.

Among the information presented by the Periodic Selector

SCOPE in INDUSTRY
SPECIALIZATION from...

ALLIS-CHALMERS



an "Outside Story" about
Allis-Chalmers products

Self-protection against weather is built into a variety of Allis-Chalmers products — electrical or mechanical. This "Outside Story" through a broad range of A-C equipment (and only A-C offers such a scope of outdoor products) *eliminates the need for costly protective enclosures in many operations.*

Pumps, motors, compressors, mechanical drive equipment, control and switchgear with inspection alleys — all are designed to perform 'round the calendar while exposed to the elements.

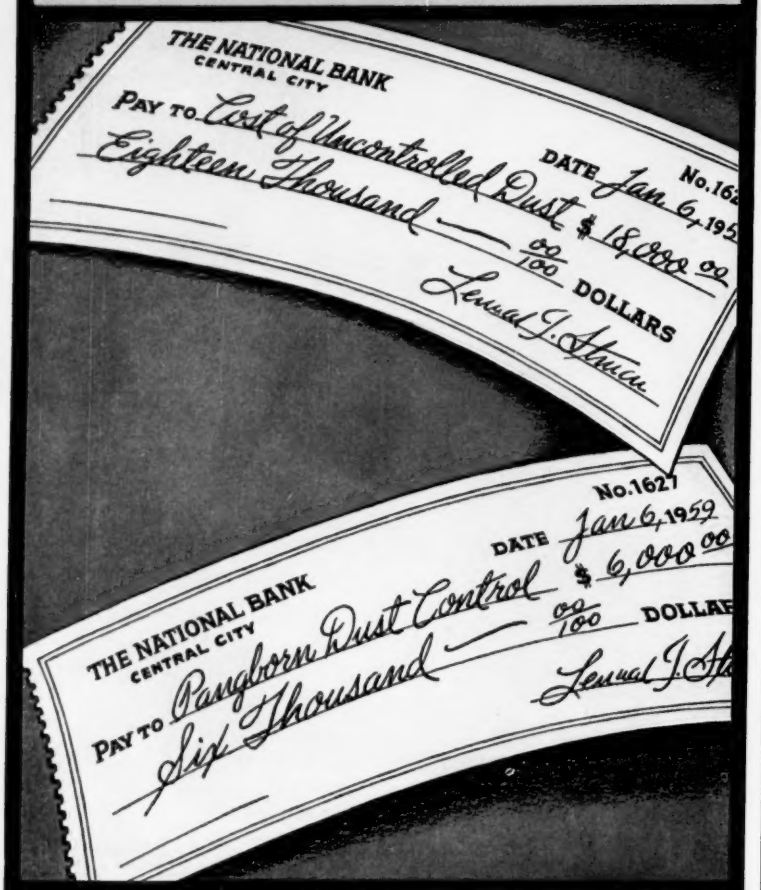
For single-source availability of a tremendous scope of up-to-date equipment, designed for outstanding quality control, contact your A-C representative. Or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Products for the Chemical Industry: Electrical Generation and Distribution Equipment; Pumps (rotary vacuum and centrifugal); Motors and Control; Mechanical Power Transmission Equipment; Processing Machinery (mills, kilns, screens, etc.); Water Conditioning Systems, plus Materials Handling Equipment.

A-C ALLIS-CHALMERS

A-5917-C

WHICH CHECK WOULD YOU RATHER WRITE?



How much are you paying for uncontrolled dust?

See for yourself—add up the cost of your lost salvageable material, housekeeping expenses, excess machine wear, intangibles such as community and employee goodwill. Whether your total is moderate or high, Pangborn Dust Control will cost you *less* than uncontrolled dust.

For details on Pangborn's engineering knowledge and experience, talk to the Pangborn man in your area or write PANGBORN CORPORATION, 2600 Pangborn Blvd., Hagerstown, Maryland. *Manufacturers of Dust Control and Blast Cleaning Equipment — Rotoblast® Steel Shot and Grit.*

Pangborn CONTROLS DUST

are electron structure of atoms; chemical activity of the elements; size of atoms and ions; density; melting point; heats of formation; etc.—**Graphic Calculator Co., Chicago, Ill. 196A**

Air Trap

Power operation assures condensate discharge.

Manufactured with stainless steel parts, the new Model 501SS compressed-air trap is available for applications where brass and copper cannot be used because of the presence of sulfide, chloride or other corrosive atmospheres.

Pressure energy from the pneumatic system opens and snap-shuts the trap's discharge valve. This action assures completely automatic condensate discharge. Working pressure ranges from 10 to 200 psig.—**Hankison Corp., Canonsburg, Pa. 198A**

Data Processing System

Expands use of existing computer installations.

Called the Multiplexer 1010, a new data processing system provides automatic transfer of programs and computer results between a central computer and as many as eight remote areas.

Equipment controls provide for three modes of operation: free access to the computer by any remote station; priority ac-

SCOPE in INDUSTRY
SPECIALIZATION from...

ALLIS-CHALMERS

Loadmaster control permits maximum loading

Typical Applications

- Twist-setting rayon cord
- Heating plastic preforms
- Setting glue joints
- Jelling rubber
- Heating inert powders
- Preheating molding powders
- Rayon drying

Continuous full capacity operation assured with Allis-Chalmers dielectric heater

Set the *Loadmaster* control at a predetermined maximum and minimum load. An automatic circuit stops the conveyor belt when the maximum load is reached. As the material in the oven dries, the belt will start again at the minimum.

Loadmaster control and the resulting full capacity operation is just one of the many features of the Allis-Chalmers dielectric heater. Eye-level, "grouped" controls facilitate a quick appraisal of operating conditions. Protective interlock assures complete safety. Oscillators and rectifiers are built to last 5000 hours or more. Heavy duty plate transformers provide large reserve capacity. Most important, Allis-Chalmers extensive engineering and research facilities assure proper application and installation.

Call your nearby A-C man for details or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

A-1001-C

A-C ALLIS-CHALMERS

Are you using wire cloth or wire cloth parts which must be corrosion resistant? Are the service conditions in your plant really tough? If you have a problem selecting the proper anti-corrosive alloy, Newark Wire Cloth may have the answer.

Available in all corrosion resistant metals, Newark Wire Cloth is accurately woven in a wide range of meshes, ranging from very coarse to extremely fine.

If you have a wire cloth problem involving corrosion, please tell us about it . . . we may have the answer.

NEWARK for ACCURACY

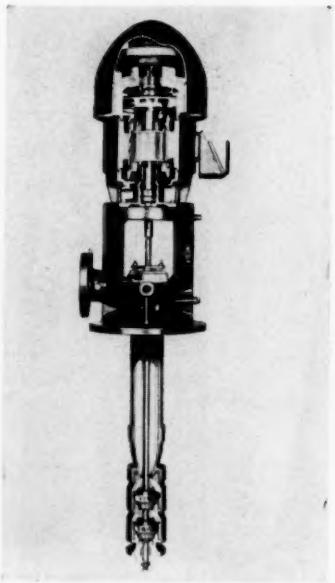
If it's wire cloth or fabricated wire cloth parts, Newark is your best source of supply. Send for our latest literature.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

cess by one remote location; and access by computer-center personnel only. Components of the system are an input control unit, output control unit and remote station consoles.

Choice of codes and input/output media are available.—**Vitro Laboratories, West Orange, N. J.** 198B



Turbine Pumps

Integral construction reduces base requirements.

Addition of 40 sizes of vertical short-coupled turbine units has expanded Allis-Chalmers' line of pumps. The new machines are available in ratings of 20 to 8,000 gpm. at heads to 400 ft. Integral construction of motor support and discharge head reduces space requirements considerably. The discharge column can be varied for changing requirements.—**Allis-Chalmers Mfg. Co., Milwaukee, Wis.** 200A

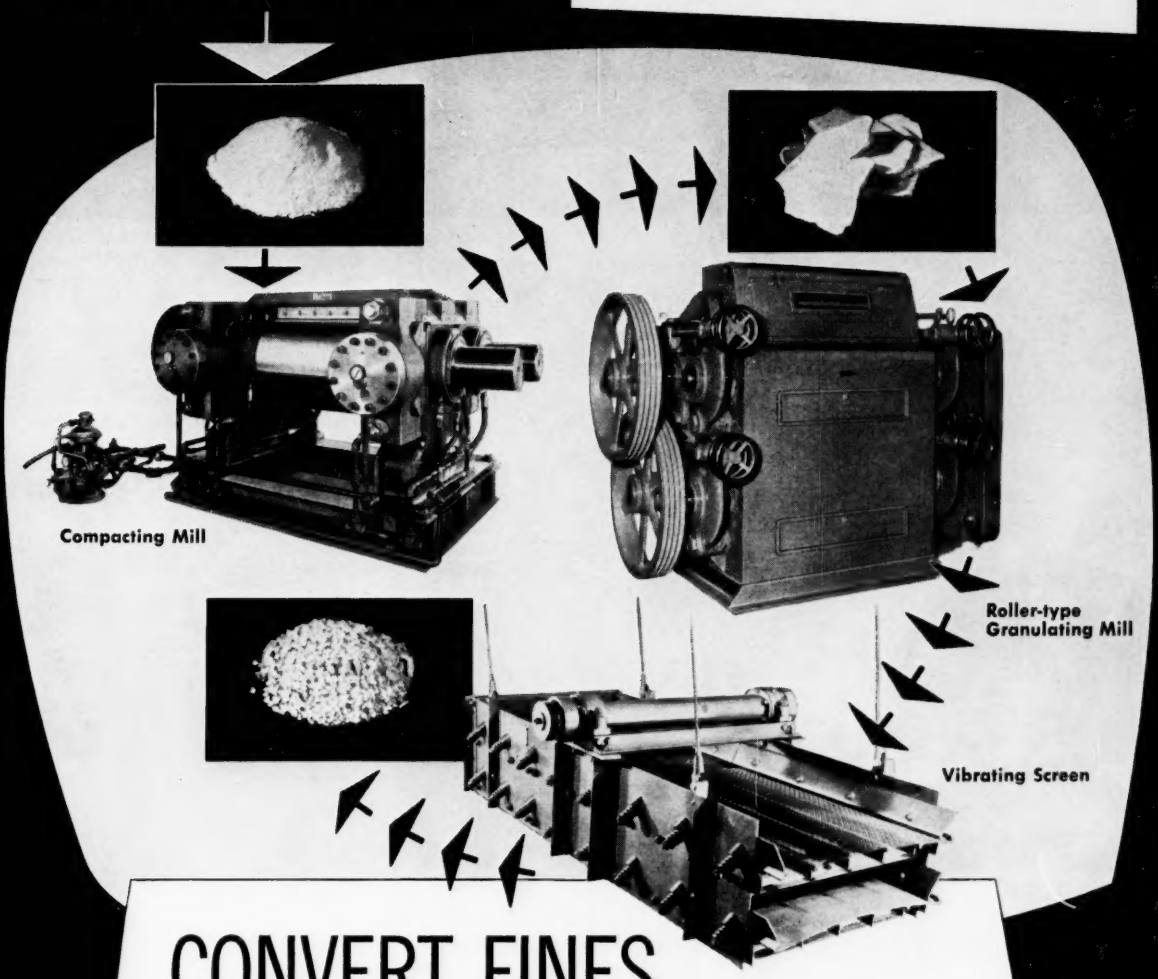
Tank-Top Attachment

Aids firefighting and simplifies maintenance.

Installed on fixed-roof liquid storage tanks, a new device

SCOPE in INDUSTRY
SPECIALIZATION from...

ALLIS-CHALMERS



CONVERT FINES

to high-quality granules with a complete processing circuit

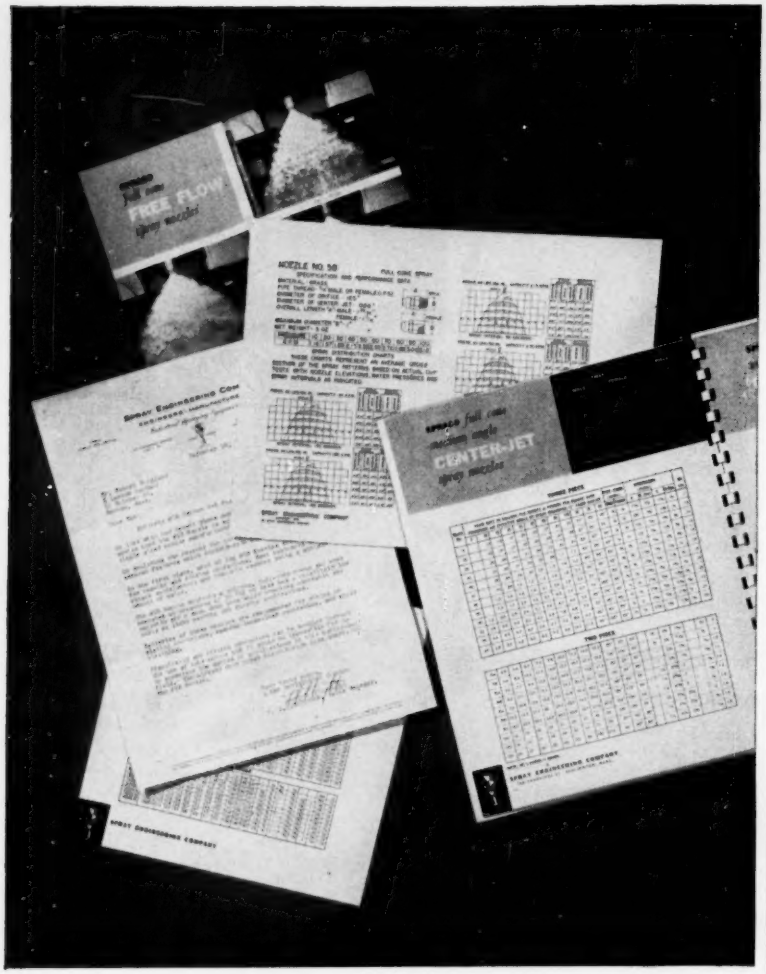
The Allis-Chalmers compacting process can turn 80 to 90% of your present waste fines into salable granules . . . often of higher quality than the granules produced in your original process. For example: Tests on products reconstituted by the Allis-Chalmers system have shown compacted granules to have better controlled solubility, more uniform particle size, better "eye-appeal" and freer flow.

Here's how fines are recovered: Waste or fine salts from the original process are fed into a compacting mill. The mill mechanically densifies the fines into flakes. Flakes are then granulated by a roller mill—separated and sized by a vibrating screen.

For more information, get Bulletin 07B8836 from your A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

A-C ALLIS-CHALMERS

A-1191-C



NOW... "SPECS" AT YOUR FINGERTIPS

Here's a surer, easier way to specify spray nozzles

How can you be sure you're specifying the *right* spray nozzle for your particular application?

Spraco's research department has taken the guesswork out of this problem by preparing complete and accurate performance data for each of the hundreds of spray nozzles in the Spraco line. Each nozzle "profile" is complete with data on material, dimensions, flow rate, pressure, angle of spray . . . everything you need to enable you to choose, at a glance, the nozzle that will deliver maximum performance and efficiency in your particular application.

No matter what your spray nozzle problem, Spraco makes this information available to you absolutely free. Why not write and ask about it — today?

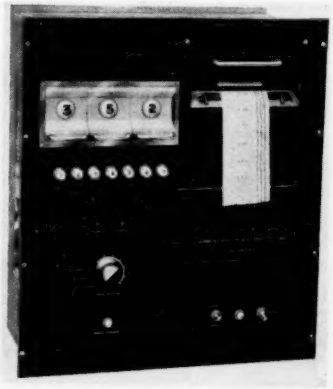
SPRAY ENGINEERING COMPANY

115 Cambridge Street, Burlington, Mass.

SPRACO

known as the Puncture-Plate admits light and air to the tank interior during maintenance work. In addition, it facilitates the use of hydraulic towers in case of fire.

Puncture-Plate consists of a steel assembly holding a strong plastic sheet that, though vapor-proof, is readily penetrated by the gooseneck of a foam tower in event of fire. This makes it easier to reach the burning surface. During maintenance work, removal of the plastic sheet ventilates the tank and admits light.—**National Foam System, Inc., West Chester, Pa. 200B**



Data Processing System

Samples, then digitizes and prints analog data.

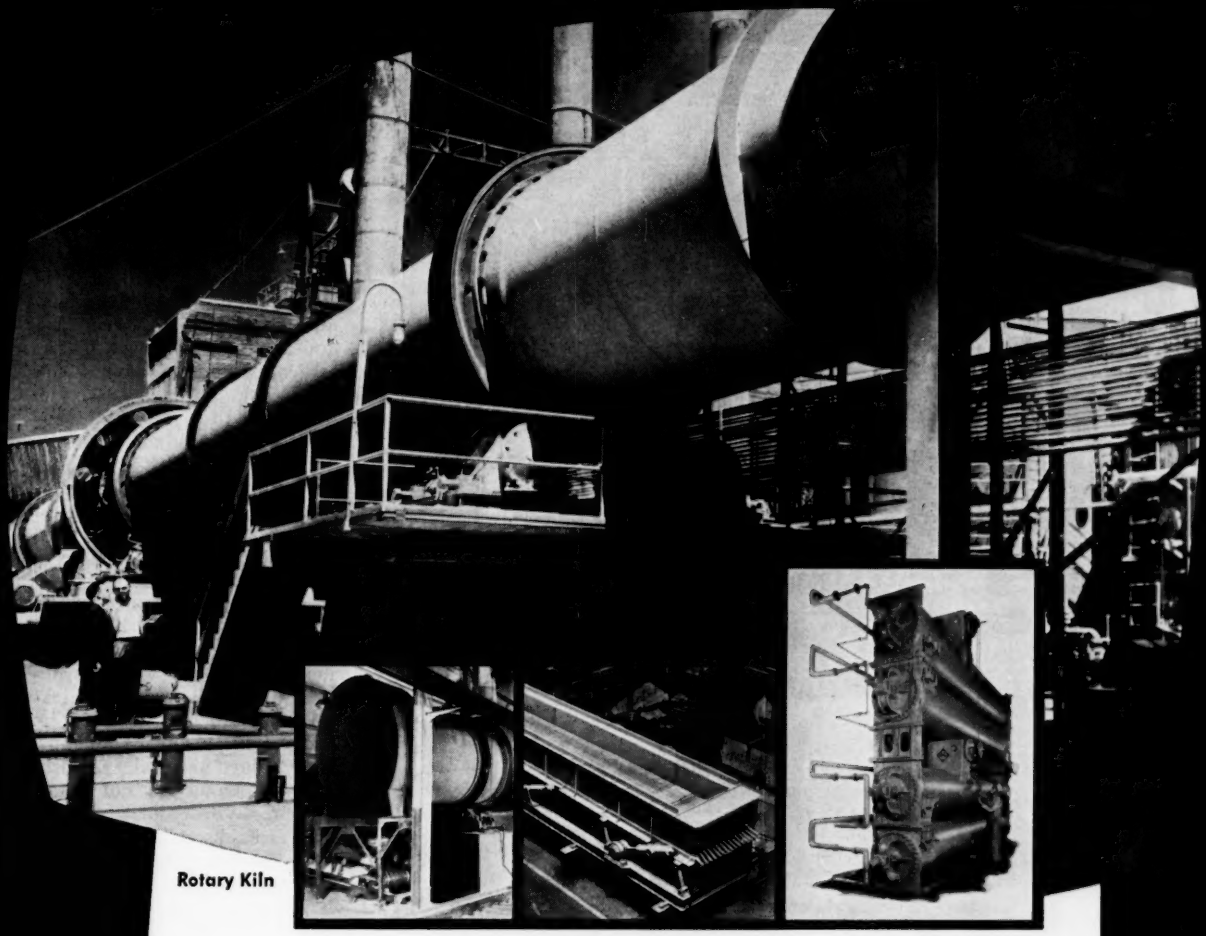
Model GDTS 821-N samples analog voltage information, digitizes the data and prints seven channels. Sampling, conversion and printing occur at the rate of three channels per second.

Nixie lamp banks provide visual output of analog voltages corrected by the proper scale factors. In addition, printed paper tape permanently records data. Digital information prints in three of the eleven columns of the printer, leaving eight columns available for additional information. Channel being scanned or printed is identified by a light display.

External command in the form of contact closures or pulses normally initiates the program's cycle of operation; however, uninterrupted recy-

SCOPE in INDUSTRY
SPECIALIZATION from...

ALLIS-CHALMERS



Rotary Kiln

Rotary Dryer

Air-Quenching Cooler

Ribbon-Flight Dryer

Integrated heat-transfer systems from Allis-Chalmers cut costs

At Allis-Chalmers, building a heat-transfer system is not just a matter of picking components and hooking them together.

A-C relates the flow variables of each component to the characteristics needed for the whole process.

Typical of the research and testing facilities which make this thorough analysis possible is the new A-C pilot plant which includes a complete *Grate-Kiln* system. Components, processes and techniques may be studied carefully under actual operating conditions. The results from these tests help A-C bring you the latest scientific advances in pyro-processing in each system you buy.

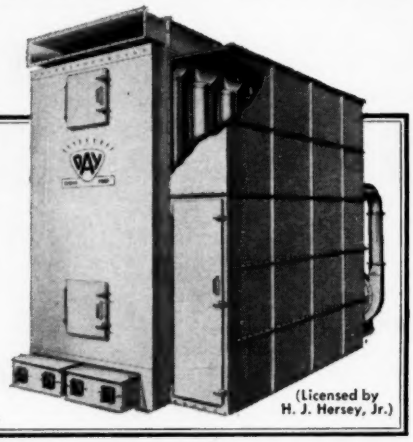
For more information, talk with your A-C representative. Or write for Bulletin 25C6177, to Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.

A-C ALLIS-CHALMERS

A-1190-C

DAY

DUST CONTROL NEWS



Largest selling filter of its type in the world!

DAY "AC" Reverse Jet Dust Filter

Cutaway view of DAY "AC"—available housed or unhoused—for pressure or suction.

(Licensed by H. J. Hersey, Jr.)

Better Dust Control Systems Cost Less When They Include a DAY "AC" Reverse Jet Filter!

Less equipment needed

Filtering rates for a DAY "AC" are 10 to 20 cubic feet of air per square foot of filter media. These are about five times greater than old style filters. This means you get maximum filtration from a minimum filter investment. Because virtually 100% of the DAY "AC" is operating at all times, no money is wasted on intermittent or standby units. One DAY "AC" will filter and keep separated, dusts from up to 10 different sources!

Less maintenance

You know all equipment requires *normal* inspection and care. But you'll find many DAY filters have been on the job for 5, 6, 7 or even 8 years that have had no repairs whatsoever. In short, *the Day "AC" is built* to last! They have an "appetite" for work and a reputation for dependability and long life.

Less space needed

Because of smaller diameter felt filter tubes the DAY "AC" gives you a greater air handling capacity in less space. DAY "AC" filters occupy up to 50% less space—an important consideration for plants of any size!

99.99+% filtering efficiency

The real "pay off" on DAY "AC" filters is their ability to clean dust laden air with near perfect efficiency! Even "tough" materials such as carbon black or atomic energy materials are filtered with optimum effectiveness.

For additional information about the DAY "AC" reverse jet dust filter write toDAY for Bulletin F-75. It also contains pages of useful air engineering data.

The DAY Company

SOLD in UNITED STATES by
The DAY SALES Company
856 Third Avenue N.E.
Minneapolis 13, Minnesota

MADE and SOLD in CANADA by
The DAY Company of Canada Limited
Rexdale (Toronto), Ontario, Canada
Ft. William, Ontario, Canada

Representatives in Principal Cities

EQUIPMENT ONLY OR A COMPLETE SYSTEM

cling is possible.—**Gerber Scientific Instrument Co., Hartford, Conn.** 202A

BRIEFS

Ultrasonic system continuously and precisely measures liquid level of liquified gases, slurries, viscous oils and molten metals. The system is fully transistorized; output is either digital or continuous, and adaptable to recording and control.—**General Ultrasonics, Bloomfield, Conn.** 204A

In-line mixer for pilot-plant application combines liquids, solids and liquids, or gases and liquids which, in combination, readily flow through piping. Unit eliminates need for intermediate storage and mixing vessels.—**Nettco Corp., Everett, Mass.** 204B

Expanded zirconium sheet, a new corrosion-resistant product, is available in thicknesses from 0.02 to 0.125 in. with ⅛- to 1½-in. diamonds, in standard sheet sizes. Withstands strong or hot phosphoric, hydrochloric or sulfuric acid solutions.—**Mallory-Sharon Metals Corp., Niles, Ohio.** 204C

Electric motors of integral-horsepower, a.c. line are offered in protected, weatherproof, totally enclosed, corrosion-proof and explosion-proof models. Sizes range from 1 to 250 hp.—**Reliance Electric & Engineering Co., Cleveland, Ohio.** 204D

Gate valves made of Causul metal can handle sulfuric acid over a wide range of concentrations. The new improved line comes in sizes from ½ to 8 in., with screwed or flanged ends. Either stainless steel or Monel trim.—**Lunkenheimer Co., Cincinnati, Ohio.** 204E

Austrian burner for liquid or gaseous fuels uses a telescopic flame tube to control physical shapes of the flame and intensity of heat without

adjustment of either fuel or air supply. Flame shape varies from long, diffused bundle to a short, conical pattern of high heat concentration. — **Oesterreichische Koerting, A. G., Vienna Austria.** 204F

Machine-applied fireproofing on the underside of any Class II roof-deck construction can result in a reclassification to permit omission of automatic sprinklers in buildings of non-combustible occupancy. The product, known as Blaze-Shield is a blend of inorganic mineral fibers and binders.— **Columbia Acoustics & Fireproofing, Stanhope, N. J.** 205A

Pipe plugs made of Delrin acetal resin seal against pressures as high as 10,000 psi. In tests, pressures of 500 psi. were held consistently, even after repeated cycling from room temperature to 250 F. Offered in many head and thread designs, the new products are also corrosion resistant and inert to virtually all solvents.—**E. I. du Pont de Nemours & Co., Wilmington, Del.** 205B

Equipment Cost Indexes . . .

	March 1959	June 1959
Industry		
Avg. of all.....	232.6	234.3
Process Industries		
Cement mfg.	225.8	227.9
Chemical	233.7	235.7
Clay products	219.4	221.5
Glass mfg.	220.7	222.5
Paint mfg.	224.4	226.6
Paper mfg.	225.2	227.1
Petroleum ind.	229.2	231.4
Rubber ind.	232.0	234.0
Process ind. avg...	230.1	232.8
Related Industries		
Elec. power equip...	236.5	246.7
Mining, milling	235.2	237.1
Refrigerating	262.2	264.7
Steam power	219.7	221.8

Compiled quarterly by Marshall and Stevens, Inc., of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124—6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.

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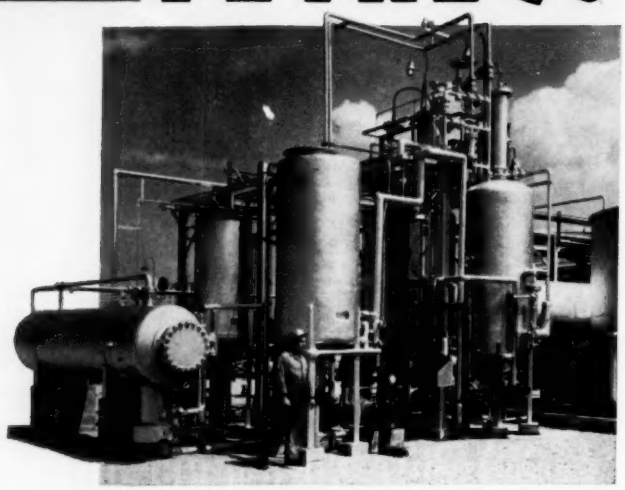

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TECHNICAL

Not Enough Change?

COLORIMETRIC DETERMINATION OF TRACES OF METALS, 3rd. ed. By E. B. Sandell. Interscience Publishers, Inc., New York. 1,032 pages. $24.

Reviewed by Robert S. Browning, Sterling-Winthrop Research Institute, Rensselaer, N. Y.

This is the most recent revision of a book first published in 1944.

The general portion has been enlarged somewhat. Radioactivation, treatment of biological materials, and chromatography all get a bit more attention. The section on reagents has been revised and expanded, and the section on separation by extraction considerably enlarged. In the portion devoted to individual metals, methods for thorium have been added and those for the other metals altered and enlarged where necessary.

The primary appeal of this book is as an excellent reference for the practising analyst, but its arrangement should make it equally useful to chemists who have to run only an occasional trace metal analysis.

Changes from the second edition, however, are not (to my mind, at least) sufficiently extensive to warrant its replacement with the third.

Expanded and Excellent

ELECTROANALYTICAL CHEMISTRY, 2nd ed. By James J. Lingane. Interscience Publishers, Inc., New York. 669 pages. $14.50.

Reviewed by Burnett C. Southworth, Sterling-Winthrop Research Institute, Rensselaer, N. Y.

The rapid growth of electroanalytical chemistry is aptly demonstrated by an increase of

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J. B. BACON

50% in the size of Dr. Lingane's book since 1953.

The first edition was an excellent catalog of the electrical methods available to the analytical chemist. The classical methods of potentiometry and conductometry were well treated after an examination of the theory of galvanic cells. Lingane then treated more modern methods such as controlled potential electrolysis and coulometry. The necessary instrumentation was well covered.

The second edition was expanded to include sections on polarography, amperometry and a larger section on coulometric technique. The section on polarography was included at the request of several teachers so as to render the book suitable as a textbook for an advanced analytical chemistry course. The section on amperometry fulfills a lack in the first edition. There are several paragraphs throughout the book which treat new methods such as differential titrators and dc current integrators.

Perhaps the most interesting part of the book is the section on coulometry. It would appear in the near future that the analytical chemist may be able to eliminate the buret entirely in favor of the coulomb as a quantitative measure of a substance.

BRIEFLY NOTED

GAS TURBINE POWER PLANTS, SM 30-1959. *National Electrical Manufacturers Assn., 155 E. 44 St., New York 17, N. Y. $1.* New publication covers: Definitions, Nomenclature, Ratings and Performance, Accessories, Shipment and Installation.

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PROPERTY MEASUREMENTS AT HIGH TEMPERATURES. By W. D. Kingery. Wiley. $16.50.

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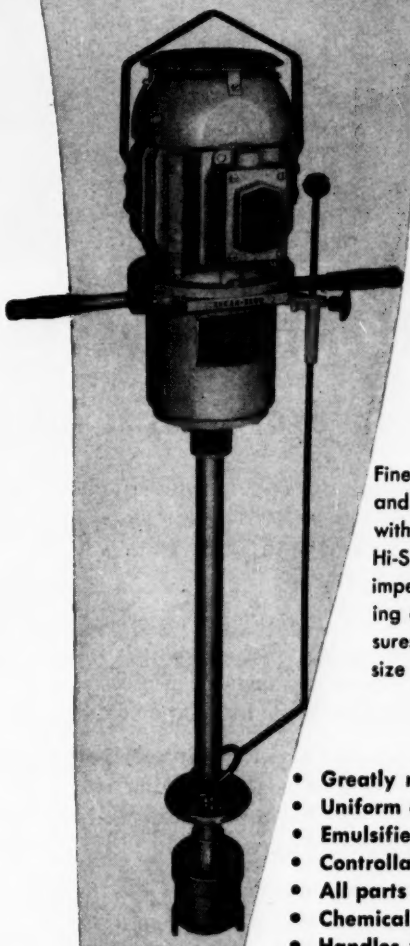

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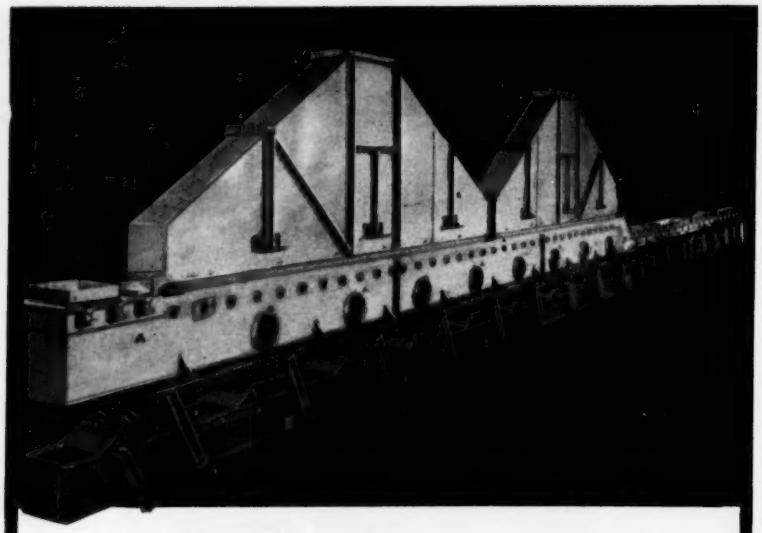

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LETTERS:

JUST BETWEEN US...

Dear Readers:

We know our profession of chemical engineering to be a particularly varied one, quite possibly the most varied one of all.

Its workings are felt throughout modern society. You, as its practitioners, are found virtually everywhere: in nuclear power plants and petroleum refineries; in ammonia plants in the farm lands, in pulp mills up in the woods and out selling on the road in between; in universities and stockbrokers' offices.

In view of this diversity, it's pretty hard to imagine that any one man could come to represent the whole of the profession; become, so to speak, "Mr. Chemical Engineering." Yet, in Sidney Dale Kirkpatrick, editorial director of *Chemical Engineering* and *Chemical Week*, we have a man who undoubtedly has come as close to doing just that as anyone is ever likely to.

In the 43 years since he earned his B.S. degree at Illinois. Sid has ranged vigorously over the entire chemical engineering landscape. And he has come to play a leading role in virtually every one of its major segments. The list of his achievements—and the awards bestowed on him in recognition of them—in areas such as technology, education and government packs nearly a full page in Who's Who.

Within the past few weeks

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still another honor has been added to this already impressive list. And it is one that underscores even further the remarkably cosmopolitan chemical engineering stature of this man. For, on September 21 at Williamsburg, Va., the Chemical Market Research Association presented Sid Kirkpatrick with its 1959 Memorial Award.

Market research, that near-scientific art of predicting the applications and profitability of a chemical product, is as much a facet of the chemical engineering profession as is the technology that went into producing the product in the first place. As such, not at all surprisingly, it too became a part of Sid's giant-size sphere of activities. He was one of CMRA's founding fathers and first officers, and he has been a dynamic figure among its membership ever since.

Chemical Industry Medalist, recipient of AIChE's Founder's Award, holder of honorary doctorates from two leading chemical engineering colleges, consulting editor of the renowned McGraw-Hill Chemical Engineering Series of textbooks, consultant to the Atomic Energy Commission the profession's representative to the government in two wars . . . now chemical market researcher of the year.

If any man can be called "Mr. Chemical Engineering", that man surely must be Sid Kirkpatrick.

T. PETER FORBATH
Chemical Engineering
Associate Editor

P.S.—Shown at the left in the Chemical Engineering," that photograph is Jim Sayre of Allied Chemical, president of CMRA.—TPF

Pro: Professional Matters

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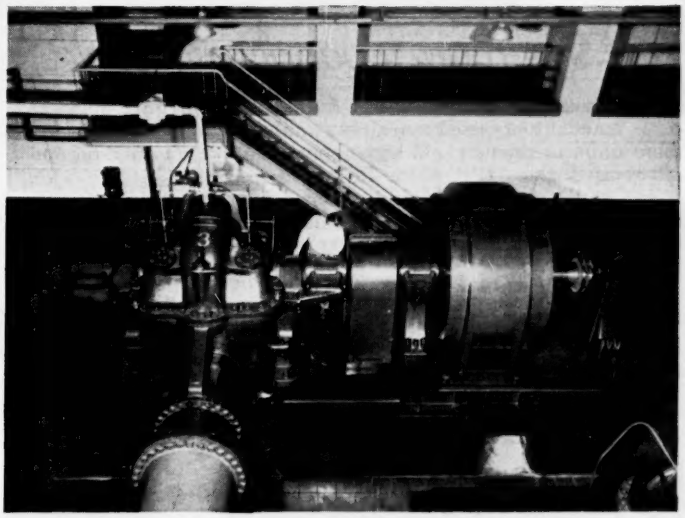

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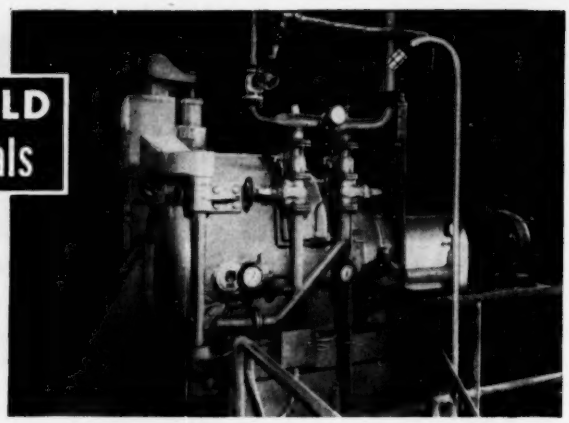

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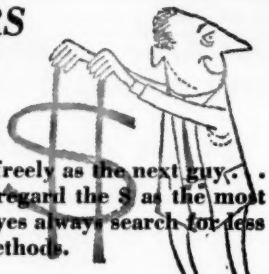

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DAN N. HENDRICKS, JR.
Seattle Professional Engineering Employees Assn.
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Interest From Pro Side

Sir:

I found much interest in your article on engineering license laws. I would like to have several copies so that we may circularize our ASCE Committee on Registration of Engineers.

E. L. CHANDLER
American Society of Civil Engineers
New York, N. Y.

Nonprofit Service

Sir:

I appreciate the story in your June 29 issue (p. 48) on AIChE's Machine Computation Committee and its activities. Your calling the attention of your readers to our efforts in promoting a useful interchange of computer program technology should expedite our committee's work.

Your mention of a prospective profit from these publications in 1960 leaves an impression that one of our chief goals is to make a publication profit.

Our primary objective is to provide a badly needed service to the chemical and petroleum industries and to insure that the service is self-supporting. The price of manuals published by AIChE will be reduced as demand increases. The $49,000 profit figure came from an exhibit to AIChE Council, along with another figure of $19,000, to show that the proposed new activity would be financially self-sustaining if the manuals were priced at $20-30 per copy.

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6-7d	24-25	59	74A	92	112	180	195A	204E	216A	219a	222d	226A	L230d	232G
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6-7g	27	64A	74D	93c	114b	183	196A	205A	216D	219d	222C	R227	TL231	242
10-11	28-29	65	74E	93d	117	184a	197	205B	216E	219A	222D	227A	BL231	244
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19b	34b	68B	79	98	159	187	200A	214	217A	220D	223D	228C	231E	246e
19c	34c	68C	80	99	161	188	200B	214A	217B	220E	224	228D	231F	240f
19d	36	68D	81	100	163	189	201	214B	217C	TL221	224A	TL229	231G	240g
19e	38-39	68E	82-83	101	165	190	202	214C	217D	BL221	224B	BL229	T232	246h
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10-11	28-29	65	74E	93d	117	184a	197	205B	216E	219A	222D	227A	BL231	244
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13	31	66B	74G	94	123	185	198A	207	216G	220	223	T228	231A	246a
14-15	32	66C	75	95	124	186a	198B	208	216H	220A	223A	B228	231B	246b
16	33	67	76	96	125	186b	199	209	216I	220B	223B	228A	231C	246c
19a	34a	68A	78	97	126	186c	200	T210	217	220C	223C	228B	231D	246d
19b	34b	68B	79	98	159	187	200A	214	217A	220D	223D	228C	231E	246e
19c	34c	68C	80	99	161	188	200B	214A	217B	220E	224	228D	231F	240f
19d	36	68D	81	100	163	189	201	214B	217C	TL221	224A	TL229	231G	240g
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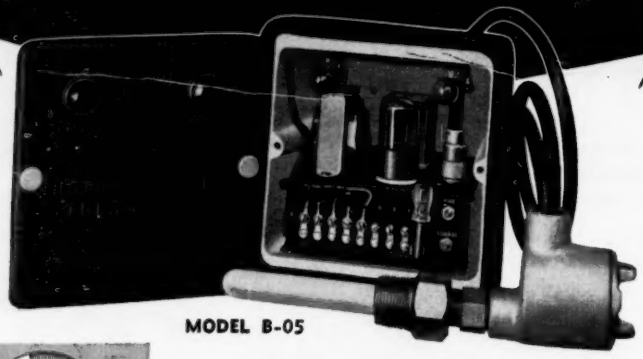

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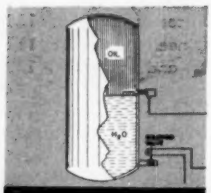

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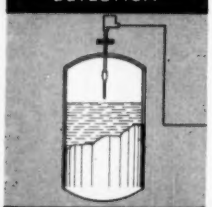

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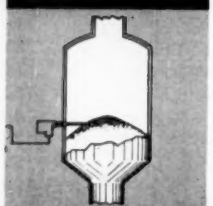

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ELECTR-O-PROBE is simple, accurate, dependable and inexpensive.

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Power Source:	90-135 VAC/60 cps
Power Demand:	9 watts probe immersed 6 watts probe uncovered
Relay:	DPDT hermetically sealed, plug-in
Rating:	5 amps/115 VAC; 2.5 amps/230 VAC
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Chemicals

Antioxidant.....Dalpac 4 for your oxidation problems. Technical information on Dalpac, its properties and possible use available on request.
100 *Hercules Powder Company

Bauxite.....Use of activated bauxite as a catalyst for recovery of 99.77% pure sulfur from hydrogen sulfide is described in 4 p. bulletin. Send for your copy.
214A Minerals & Chemicals Corp.

Borohydride.....Complete information MHI sodium borohydride & potassium borohydride is now available. Alcohols, Amines, Nitriles, etc. respond to borohydride treatment.
63 *Metal Hydrides Incorporated

Butylene Oxide.....6 p. bulletin describes 1,2-butylene oxide, first single-isomer butylene oxide commercially available. Covers actual & potential uses, derivatives.
214B Dow Chemical Co.

Caulking Compound.....4 p. brochure contains application and test data on alkyd resin base compound for caulking around wood and metal frames in masonry, glazing.
214C L. Sonneborn Sons, Inc.

Chemicals, Industrial....."Diamond Chemicals for Industry" covers 200 chemicals in 75 p. Cross references & indexes show their application in various industries.
214D Diamond Alkali Co.

Chemicals.....12 p. bulletin 100-C describes acids, alkalies, elements, metallic salts, phosphorus compounds, chlorides, chlorobenzenes, sulfur compounds.
214E Hooker Chemical Corp.

Chemicals for Export.....20 p. bulletin No. 11 contains brief descriptions, physical data, uses and packaging information with respect to 31 chemicals offered for export.
214F Hooker Chemical Corp.

* From advertisement, this issue

LITERATURE

E. M. FLYNN

Chromium Oxides.....Pure Chromium Oxide & Hydraded Chromium Oxide are unaffected by acids, alkalis, vehicles, & solvents. Tech. data & samples are offered.
205 *C. K. Williams

Ethylene Oxide.....48 p. manual brings up to date available information on physical & chemical properties, specifications, analytical procedures, and industrial uses.
17 General Aniline & Film

Fatty Acids.....32 p. booklet, "The Chemistry of Fatty Acids," describes the preparation, characteristics and application of 30 fatty acids trademarked Neo-Fat.
215B Armour Industrial Chemical

Filter Aid.....Solka-Floc is virtually 100% pure cellulose & offers more advantages as a filter medium in many food processing applications. Facts available.
242 *Brown Co.

Filter Fabrics.....A handy booklet of information about filter fabrics is now available on request. It offers help in the selection of filter fabrics.
157 *Wellington Sears Co.

Fluorides.....line includes more than 75 inorganic fluorine compounds. Complete list of fluorides & fluoborates & further data on specific products of interest to you.
41 *General Chem. Div., Allied Chem.

Fluorocarbon Resins.....Piston rings made with Tefion resins cut replacement & maintenance costs. Details about fluorocarbon resins & how they can improve seals.
31 *E. I. du Pont de Nemours & Co.

Industrial Filter Paper.....A comparative chart of Industrial Filter Papers plus filter paper application guide for proper filtration of scores of products in Cat. 357.
184a *The Eaton-Dikeman Co.

Industrial Paper Sample.....book No. 459 contains actual samples of the filter papers discussed in the industrial Filter Paper Catalog. Available now.
184b *The Eaton-Dikeman Co.

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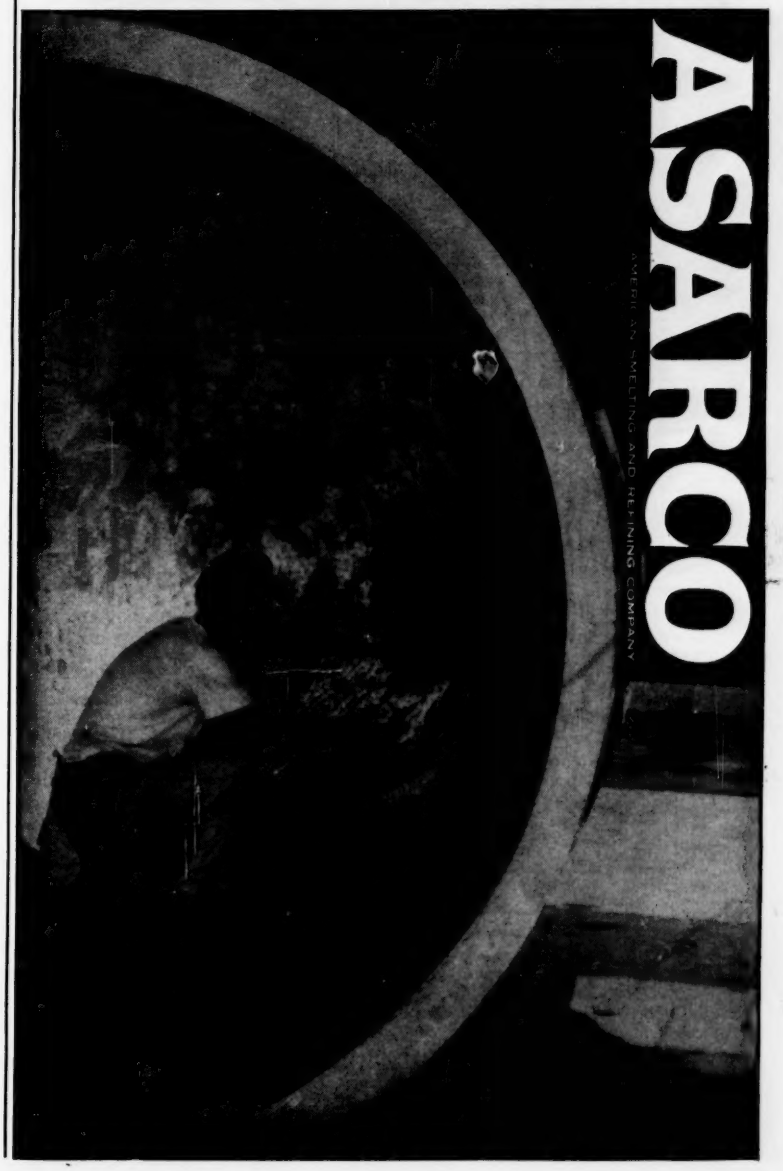

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Isocyanates.....Ethyl Isocyanate, Propyl Isocyanate & Butyl Isocyanate are chemists' choice for unambiguous syntheses of new drugs & chemicals. Information.
R225 *The Carwin Company

Lubricating Grease.....Rykon grease is heat stable and mechanically stable. Resistant to water washing & has exceptional rust preventive properties. Facts.
99 *Standard Oil Co. (Indiana)

Mineral Products.....8 p. booklet presents properties of aluminum silicate pigments, Attapulgus clays, activated bauxites and limestone products.
216A Minerals & Chemicals Corp.

Molecular Sieves.....7 p. leaflet describes their use as a latent accelerator for Neoprene: 1,3 diethyl thiorurea adsorbed on molecular sieve type 13X.
216B Linde Co.

Organic Chemicals, Aliphatic.....10 p. booklet lists specifications and chemical composition of long and short chain fatty acids, oleic and unsaturated fatty acids.
216C Armour Industrial Chemical

Reagents.....365 p. book, free to qualified laboratories, describes 7,000-plus chemicals in one alphabetical listing. All ACS specified reagents are included.
216D Fisher Scientific Co.

Resin.....Epon 1002 is a new grade of resin that is hard & free-flowing at elevated temperatures. Complete information, including technical bulletin SC:58-107 offered.
Cover *Shell Chemical Corp.

Sodium.....Convenient process and equipment for converting metallic sodium into wire are described in a technical data sheet, "Laboratory Production & Use of Sodium Wire."
216E U. S. Industrial Chemicals

Styrene.....28 p. booklet on expandable polystyrene covers applications, properties, processing techniques, and handling. All sections illustrated with photos and charts.
216F Koppers Co.

Thickening Agent.....4 p. leaflet explains how to thicken latices with Carbopol 934, a carboxy vinyl polymer of extremely high molecular weight.
216G B. F. Goodrich Chemical Co.

Trichlorethylene.....36 p. "Nialk Trichlorethylene for Vapor Degreasing & Other Uses", booklet 44-A, is an expanded edition on a chlorinated solvent of high purity.
216H Hooker Chemical Co.

Water.....Bulletin No. 16 lists the individual & comprehensive tests that are available. Laboratories offer analyses, research and development. Send for your copy.
216I Crippen Laboratories, Inc.

Construction material

Alloy.....The engineering properties of Ni-O-Nel alloy & detailed data on its record of corrosion resistance is contained in "The Corrosion Resistance of Ni-O-Nel" booklet.
94 *International Nickel Co.

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Coating, Zinc.....is completely nonflamable, nontoxic & is insoluble in all petroleum products. Applied by brush, spray or roller. Resists temp. up to 600F. Details.
179 *Amercoat Corp.

Coatings.....Folder gives a rational basis for paint & painting specifications & tells how all surface & area exposures can be classified into 4 Categories of Corrosion.
49 *Hercules Powder Co., Inc.

Corrosion Guide.....Comprehensive, 24-page corrosion guide for fasteners tabulates physical and mechanical properties for metal fasteners. Cross-referenced to MS.
217A H. M. Harper Co.

Insulation.....Revised catalog describes and illustrates a line of bonded mica insulation. Information on grades, forms, sizes, weights and fabricating aids included.
217B Continental-Diamond Fibre

Insulation.....Manual of insulation specifications has been re-issued in enlarged and thoroughly revised form. Tables give recommended thicknesses.
217C Johns-Manville

Lead.....is one of the most efficient & economical protection materials against many acids. The Lead Handbook for the chemical process industries is offered. Bul. 162.
215 *American Smelting & Refining Co.

Metallizing.....New metallizing handbook contains 345 pages of information on spraying, in powder form, of high-melting-point ceramics and hard-facing alloys.
217D Metallizing Engineering

Packings.....Chempro Style No. 300 "Cup & Con" & Style No. 305 "Wedge" packing ring sets make tight, secure seals under minimum gland pressure. Bulletin CP-552.
30 *Chemical & Power Products, Inc.

Plastic.....Penton is readily fabricated or machined from sheet, rod, or block stock. It can also be applied as a coating on metal surfaces. List of commercial uses.
4 Hercules Powder Co.

Plastic.....Literature on new Teflon products available to the chemical industry is now available. Includes new expansion joint, thin-wall tubing & larger sheet sizes.
196 *Raybestos-Manhattan, Inc.

Protective Coatings.....A series of three case history folders describes applications of protective coating systems. Also information on selection for specific jobs.
217E Metalweld, Inc.

Protective Coatings.....for steel tank linings, concrete tank lining, tank cars, concrete floors, etc. Booklet describes protective coatings & other Plasite products.
R227 *Wisconsin Protective Coating Co.

Refractories.....A new brochure describes complete line of refractories for petroleum refining & petrochemical applications including all classes of castables, etc.
14-15 *Harbison-Walker

Resin.....A wide variety of resin formulations to provide complete protection under almost any condition. Solve your corrosion & contamination problems. Bul. 100.
187 *Du Verre, Inc.

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CE-10

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LITERATURE . . .

Stainless Steel.....Folder gives information on the welding characteristics of austenitic and ferritic types of stainless steel. Pertinent to piping, tubing.
218A Babcock & Wilcox

Steel.....Union 20-S is a new source for pipe, tube, strip, sheet, plate, bar, & wire. Complete information contained in Bulletin 20-S. Send for your copy.
65 *Union Steel Corp.

Tube and Bar Stock.....Detailed information on standard bar and tube stock made of GC Meehanite metal, GA Meehanite metal and Type #1 Ni-Resist included in bulletin.
218B Shenango Furnace Co.

Wire Cloth.....available in all corrosion resistant metals, in a wide range of meshes, ranging from very coarse to extremely fine. Latest literature available.
200 *Newark Wire Cloth Co.

Electrical & mechanical

Air Motors.....How "air may do the job" through use of air motors, compressors and vacuum pumps is the subject of Booklet App-15. Case histories and diagrams.
218C Gast Mfg. Corp.

Ball Bearings.....Bulletin 110 provides complete information about many types and sizes of deep-groove ball bearings. Dimensions, loads and application data.
218D Hoover Ball & Bearing

Dielectric Heaters.....Loadmaster control & the resulting full capacity operation is just one of the many features of the dielectric heater. Details.
199 *Allis-Chalmers

Dowmotor Powered Actuators..... Series 1542 & 1544 are available for any application requiring accurate positioning in response to a pneumatic signal. Bul. 1236-ST.
93a *The Annin Company

Drive.....Bulletin 3600 outlines the Allispede Drive. Available in sizes up to 30 hp, output speeds from 1 to 10,000 rpm, & speed ranges up to 8:1.
111 *The Louis Allis Co.

Electrical Connectors.....Bulletin 2711 contains complete descriptions, specifications and configuration patterns for both type RPE and type RPC.
36 *Crouse Hinds

Electro-Hydraulic Actuators.....Provides a means of converting an electrical signal to a powerful hydraulic positioning force. Bul. 1236-ST outlines the 20,000 Series.
93d *The Annin Company

Expansion Joints.....A complete line of solid Teflon and Teflon lined expansion joints. Will withstand temperatures above 175 F. Catalog AD-137 offered.
81 *The Garlock Packing Co.

Gearmotors.....Bulletin contains technical information on horizontal and vertical gearmotors with capacity to 125 hp. and output speeds from 1.2 to 780 rpm.
218E Hewitt-Robins, Inc.

* From advertisement, this issue

Gas Turbine.....Catalog sheet describes a lightweight, miniature gas turbine engine available in 5 and 10-hp. models. Advantages and methods of operation.
219A Curtiss-Wright Corp.

Mechanical Seals.....meet a wide range of pressures, temperatures & liquids. Sealing of corrosive, volatile & abrasive conditions. Catalog No. 480 CE.
R226 *Durametallic Corporation

Pneumatic-Hydraulic Actuators..... The 10,000 Series is covered in Bulletin 1236-ST. For valves requiring strokes to 6 inches & thrusts to 100,000 lbs.
93c *The Annin Company

Stroke Positioning Actuators.....are primarily for the control of variable speed drives, rheostats, pumps & cams, as well as control valves. Bul. 1236-ST.
93b *The Annin Company

Toggle Actuators.....for process requirements where the unbalanced forces are extremely high, or where large through-puts are required. Bulletin 1236-ST.
93e *The Annin Company

Turbines.....YR turbines offer all-weather protection. They shrug off heat, dirt, snow, moisture or contaminated atmosphere. Feature steam-saving hand valve.
28-29 *Elliott Co.

Handling & packaging

Conveyor.....Airslide Fluidizing Conveyor fluidizes dry, pulverized materials with low pressure air. Take up little space, can be used singly & in combination.
80 *Fuller Co.

Cylinders.....Seamless or welded cylinders are made in all shapes & sizes for all services. Many advantages for high or low service. Complete facts & prices offered.
13 *Pressed Steel Tank Co.

Materials Handling.....Trackmobile is a most versatile machine that transfers easily from rail to road. Additional information contained in Bulletin 245.
69 *Whiting Corp.

Pneumatic Conveying System.....for dry solids conveying of cement, fertilizers, pulverized coal, pharmaceuticals, powered & granular dry chemicals, etc.
108 *Kennedy Van Saun

Safety Fork Lift Trucks.....New bulletin describes Models FTDX with 3000 to 8000 capacities. Covers features of the hydraulic starter, auxiliary hand pump, etc.
219B Allis-Chalmers, Buda Div.

Screw Conveyor System.....has widest range of components for screw conveyor applications — various types of flighting, gates, troughs, drives, etc. Book 2989.
12 Link-Belt Co.

Screw Elevators.....The Rotor Lift is quick opening, easy to clean, & fast closing. Eight basic types, four diameters. Catalog offered.
TL221 *Southwestern Supply & Machine

* From advertisement, this issue

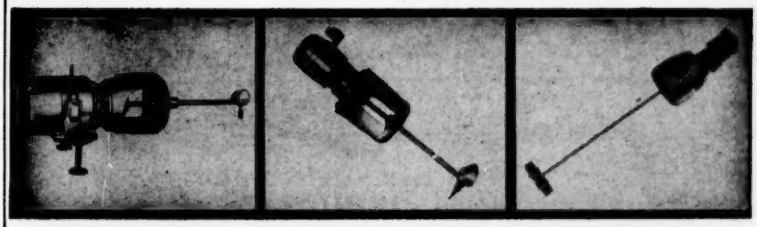
EASTERN MIXERS

mix fluids quickly . . . thoroughly

EASTERN'S COMPLETE LINE of fluid mixers range from fixed-mounted 40 H.P. turbines and heavy-duty propeller mixers to lightweight portables. Where fixed-mounted installations are not required, Eastern Portables offer versatility, ease of handling and long-term cost savings.

Portables are available with speeds of 420, 1125 and 1725 R.P.M., rated from 1/20 to 3 H.P. as standard, with variable speed and air-driven models also available. Motors in all standard types can be supplied in open drip-proof, totally-enclosed, or explosion-proof construction. Shafts and single or dual propellers are available in a choice of alloys for all service requirements. New optional ball-swivel clamp as illustrated, permits easy adjustment of mixer position in tank.

For a personalized analysis of your mixing problems, send details to Eastern engineers. A recommended solution will be furnished promptly and without obligation. For a helpful guide to mixing fundamentals, write for "Handbook of Fluid Mixing."



SIDE-ENTERING MIXERS
Handle the extra heavy-duty jobs in big tanks. Sizes ¼ to 30 H.P. Send for Bulletin 620.

TOP ENTERING MIXERS
Designed for heavy-duty applications requiring agitators from ¼ to 10 H.P. Send for Bulletin 620.

TURBINE MIXERS
Range of ¼ to 40 H.P. solve many special mixing problems. Send for Bulletin 1210.

NEW PORTABLE MIXER BULLETIN

Eastern's improved line is included in the revised Bulletin No. 530.

Eastern INDUSTRIES, INC.
Dept. A-3, Norwalk, Conn.

the V-notch is the difference in chlorine control

Safe chlorine control is the job of a chlorinator.
This control, the V-notch, does the job completely.
Yet it appears to be simply a grooved plug in a ring.
It is, of course, more than that... much more.
The groove in the plug is precision milled and shaped so that when you turn the control knob on your chlorinator and the plug slides through the ring, the size of the opening between the groove and the ring changes an exact amount. You meter chlorine exactly and simply because every position of the plug in the ring makes a repeatable orifice size—a repeatable chlorine flow rate.
Only in a W&T V-notch Chlorinator is control so simple, so true, so precisely right.
And, of course, the right plastics make the whole chlorinator chlorine-proof.

A booklet, "The V-notch Story" will tell you about all the W&T V-notch Chlorinator features. For your copy write Dept S-127.29

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

W&T Chemical Solution Feeders furnish

ACCURATE...RELIABLE...FULL STRENGTH

hypochlorite dosage for bacterial control of small water supplies.

Be safe; ask for them; Write Dept. L-2.29

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

LITERATURE . . .

Side Transfer.....Brochure describes a new concept of material handling, the STOW side transfer warehouse device. Unit cuts required aisle space by 50%.
220A Equipment Mfg., Inc.

Truck Manual.....Serves as guide for industrial truck operators' training program. Covers theory of operation, good driving practices, practical operation, exams, etc.
220B Automatic Transportation

Heating & Cooling

Cartridge Heaters.....that smoothly fit standard drilled holes in dies, platens, molds, extrusion & injection barrels. Catalog 60 provides detailed information.
186c *Edwin L. Wiegand Co.

Chlorinator.....The V-notch chlorinator offers safe chlorine control. Booklet, "The V-notch Story" tells all about the many features. Send for your copy.
220 *Wallace & Tiernan Inc.

Cooling Towers.....Class 600 Cross-Flow cooling towers are covered in Bulletin CF-59. All longer-life factors are covered in complete detail.
167 *The Marley Company

Cryogenerators.....Folder titled "Norelco Cryogenerators — For Gas Liquefaction Systems" is available gratis. Engineering information on four models. Applications.
220C North American Philips

Exchangers, Scraped Surface.....for special heat transfer & crystallization problems are fully covered in literature which is available on request.
126 *Henry Vogt Machine Co.

Heat exchanger.....The C-100 can be used as a heater, cooler, condenser or vaporizer for hundreds of process applications. Newly illustrated Bul. 302.5K1.
87 *American-Standard

Heat exchanger Tube.....for applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in popular alloys.
97 *Scovill Mfg. Co.

Heat Transfer.....Multi-zone Plate-coil configuration with multiple headers produces a reserve capacity for faster start-up & better temperature maintenance. Bul. P61.
90 *Tranter Mfg. Inc.

Heat Transfer Cements.....Engineering Data Book 502 contains information on properties & uses. Includes estimating & installation data, illustrations, etc.
220D Thermon Mfg. Co.

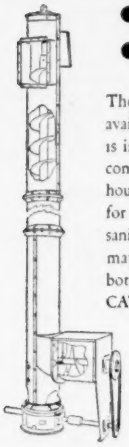
Heat Transfer Equipment.....Complete line of heat exchangers, fired indirect heaters, tank heaters, packaged boilers and custom equipment is covered in Bul. 593.
220E Brown Fintube Co.

Steam Traps.....Selector Chart in Strong Catalog No. 69A gives trap recommendations for 45 types of equipment. Steam Traps for every type of service.
88 *Strong, Carlisle & Hammond

* From advertisement, this issue

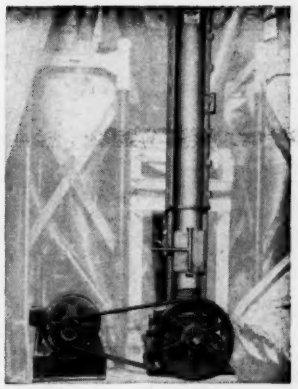
CHEMICAL PROCESSORS!
THE *Rotor Lift* IS-

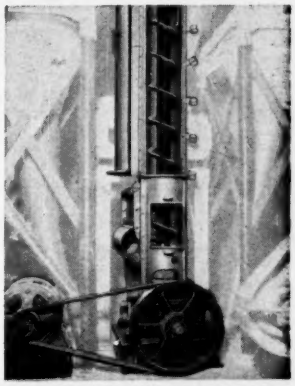
- QUICK OPENING
- EASY TO CLEAN
- FAST CLOSING



The quick opening-fast closing feature available in ROTOR LIFT screw elevators is invaluable wherever purity of material conveyed is vital. Vertically-hinged split housing gives quick, complete accessibility for thorough clean-out with unexcelled sanitation control. Horizontal intake hopper may also be equipped with hinged drop bottom. WRITE FOR ENGINEERING CATALOG.

LOW CARBON STEEL
STAINLESS STEEL
GALVANIZED (HOT DIPPED)
8 BASIC TYPES • 4 DIAMETERS

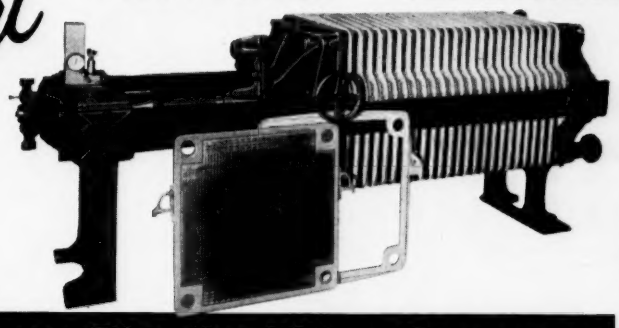




SOUTHWESTERN
SUPPLY and MACHINE WORKS
OKLAHOMA CITY, OKLAHOMA

WORLD'S LARGEST MANUFACTURER OF VERTICAL HELICOID SCREW ELEVATORS

Get "PROTECTED" FILTRATION



in

Shriver Plastic Filter Presses

To resist corrosion and contamination, Shriver Filter Presses are now available with plates and frames of Fiberglas—reinforced polyester, Haveg, rubber, impregnated wood, and metal covered with polyvinyl chloride, other plastics or rubber.

Plates and frames of these materials can be furnished at lower cost than those of equally corrosion-resistant metals. They are often even more satisfactory. We invite your inquiries.

T. SHRIVER & COMPANY, INC.
802 HAMILTON STREET • HARRISON, N. J.
SALES REPRESENTATIVES IN: Chicago, Ill.—Atlanta, Ga.—Houston, Tex.—Detroit, Mich. St. Louis, Mo.—San Francisco, Cal.—Montreal, Que.—Toronto, Ont.

FILTER PRESSES • VERTICAL LEAF FILTERS • FILTER MEDIA
HORIZONTAL PLATE FILTERS • CONTINUOUS THICKENERS
SLAB FORMERS • DIAPHRAGM PUMPS • ELECTROLYTIC CELLS

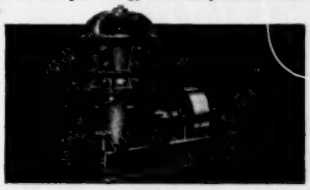
NO MAJOR REPAIRS IN 25 YEARS*

Sturteyant Construction Assures Long Mill Life at Top Loads

Sturtevant crushing and grinding machinery answers the long life top-load production problem for medium to small size plants. Many Sturtevants have been operating above rated capacities for more than 25 years, and *without a major repair.*

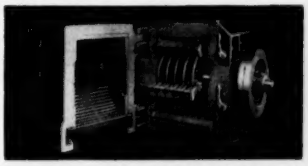
"Open-Door" design gives instant accessibility where needed — makes cleanouts, inspection and maintenance fast and easy. Machines may be set up in units to operate at equal quality and capacity.

Jaw Crushers — Produce coarse (5 in. largest model) to fine (⅛ in. smallest model). Eight models range from 2 x 6 in. jaw opening (lab model) to 12 x 26 in. Capacities to 30 tph. All except two smallest sizes operate on double cam principle — crush double per energy unit. *Request Bulletin No. 062.*



Rotary Fine Crusher — Reduce soft to medium hard 3 to 8 in. material down to ¼ to 1¼ in. sizes. Capacities up to 30 tph. Smallest model has 6 x 18 in. hopper opening; largest, 10 x 30 in. Non-clogging operation. Single handwheel regulates size. *Request Bulletin No. 063.*

Crushing Rolls — Reduce soft to hard 2 in. and smaller materials to from 12 to 20 mesh with minimum fines. Eight sizes, with rolls from 8 x 5 in. to 38 x 20 in.; rates to 87 tph. Three types — Balanced Rolls; Plain Balanced Rolls; Laboratory Rolls — all may be adjusted in operation. *Request Bulletin No. 065.*



Hammer Mills — Reduce to 20 mesh. Swing-Sledge Mills crush or shred medium hard material up to 70 tph. Hinged-Hammer Pulverizers crush or shred softer material at rates up to 30 tph. Four Swing-Sledge Mills with feed openings from 6 x 5 in. to 20 x 30½ in. Four Hinged-Hammer Pulverizers with feed openings from 12 x 12 in. to 12½ x 24 in. *Request Bulletin No. 084.*

**Reports Manager W. Carleton Merrill concerning Sturtevant Swing-Sledge Mill at James F. Morse Co., Boston.*

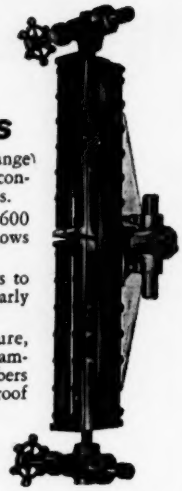
STURTEVANT
MILL COMPANY
100 Clayton St., Boston 22, Mass.

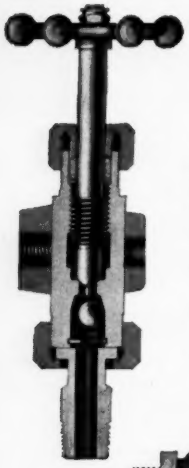
MEASURE
MIX
PUMP
EXHAUST
WASH
AERATE
AGITATE
COMPRESS
ATOMIZE
CIRCULATE
INJECT
EXTRACT

PENBERTHY
Direct Reading
LIQUID LEVEL GAGES

Designed with exclusive features for range of pressures, temperatures, corrosive conditions or other specific requirements.

- **REFLEX** — 3 pressure groups to 3600 psig. Lengths to 12 ft. Liquid shows black for positive accuracy.
- **TRANSPARENT** — 4 pressure groups to 10,000 psig. Lengths to 12 ft. Clearly shows color, density on media.
- **SPECIAL SERVICE** — High pressure, Frost-Proof, Heating Tube and Chamber, Welding Pad, Large Chambers and Inclined Gages, Explosion-Proof Illuminator.





PENBERTHY
GAGE VALVES

Exclusive "floating shank" saves on installation, eliminates strains common to forced installations.

- Threaded Valves for service to 6000 PSI
- Threaded Valves for service to 1500 PSI
- Stuffing Box Valves for service to 750 PSI
- Special Valves and Accessories.

PENBERTHY
EJECTORS

Hydraulic, air and steam operated Penberthy ejectors (jet pumps, eductors, exhausters and syphons) simplify handling of fluids, vapors, gases and "hot" materials. In a variety of standard and special designs and materials.

PENBERTHY
SUMP PUMPS

Automatic, electric, explosion-proof, submersible and standard types in 8 models, 20 sizes.

Your request for literature or specific engineering data, for any or all Penberthy products, will receive prompt, personal attention.

PENBERTHY MANUFACTURING COMPANY
Division of Buffalo-Eclipse Corporation
PROPHETSTOWN, ILLINOIS

There's Certain Satisfaction in **PRODUCTS BY** PENBERTHY

- EJECTORS
- INJECTORS
- CYCLING JET PUMPS
- LIQUID LEVEL GAGES
- GAGE VALVES
- SUMP PUMPS

LITERATURE . . .

Strip Heaters.....that quickly & easily bolt or clamp to platens, dies, kettles, tanks, pipes, rolls, drums, ovens & air ducts. Detailed product information in Catalog 60.
186a *Edwin L. Wiegand Co.

Thermo Panels.....Form DW-6 tells all about Dean Drum Warmers & Coolers. Also complete data & prices on all heat transfer equipment and latest models.
T232 *Dean Products Inc.

Tubular Heaters.....that clamp on, fit into machined grooves, cast into metals, immerse in liquids, install in ovens & ducts. Available with brazed-on fins. Cat. 60.
186b *Edwin L. Wiegand Co.

Instruments & controls

Analog-To-Digital Recorder.....Catalog describes shaft-input device that converts and records analog values in digital, binary-decimal punched-tape form. Telemeter use.
222A Fischer & Porter

Chlorination Cell....."The Diamond Chlorination Cell" is the title of a comprehensive brochure now available. Technical data on sensing element. Applications.
222B Diamond Alkali Co.

Chromatograph, Industrial Gas..... Detailed instrument specifications and answers to your process control problems are contained in data file 14-43-07.
89 *Beckman Instruments, Inc.

Chromatography Equipment.....New tritium detector offers outstanding operating flexibility. Same detector can be used for capillary or packed columns.
123 *Barber-Colman Co.

Combustion Control.....Diagrammatic and schematic drawings are used to show Cyclone Furnace Combustion Control Systems in Bulletin 514. List of installations.
222C Bailey Meter Co.

Compressor Control.....Control systems for completely automatic operation and protection of gas-engine compressors is described in a new flier. Illustrated.
222D Ingersoll-Rand

Consistency Control.....Bulletin "The New Concept in Consistency Control" discusses manufacturer's new regulator. Operation details and application predictions.
222E Fischer & Porter

Controls.....New recording pneumatic temperature control, model RVA is available in any 10 ranges from 30 to 1100 F. Recording, indicating & non-indicating models. Details.
96 *The Partlow Corp.

Controls, Airline....."Tri-Duty" includes; automatic Water Separator, new Air Regulator with gauge and automatic Airline Lubricator. Facts available.
85 *Alemite Div., Stewart-Warner

Electronic Relay.....Electr-o-probe tank or bin level control is available for interface detection, liquid level detection and solid level detection.
214 *Instruments, Inc.

* From advertisement, this issue

Flame Failure Device.....Bulletin highlights the safety factor of a unit for eliminating explosions in oil, coal and gas installations. Principles of operation.
223A Photomation, Inc.

Flowmeters.....New catalog combines all basic information on a complete line of flowmeters, flowswitches and manometers. Units for gases, liquids or both gases and liquids.
223B Seico Instrument Div.

Gages, Heated.....In the complete line there is a model to meet your specific needs...heated by steam or electrically.....heavy or viscous liquids. Catalog offered.
L227 *Jerguson Gage & Valve Co.

Gages, Liquid Level.....Direct reading type designed with exclusive features for range of pressure, temperatures, corrosive conditions or other specific requirements. Lit.
222a Penberthy Mfg. Co.

Level Transmitters.....Type 13 FA is accurate to ± ½% on all types of liquids—from water, to highly viscous & corrosive liquids. Details in Bul. 458-52.
103 *The Foxboro Co.

Meters.....Inline electronic turbine type meters offer capacities from 0.1 GPM to 40,000 GPM. Information on this type plus Xacto Meters & Proportioners in Catalog.
27 *Bowser, Inc.

Meters, Industrial.....can measure most any piped liquid—oil, liquors, paints, chemical solutions—over 50 liquids in all. Full details are available.
193 *Rockwell Mfg. Co.

Process Control System.....The new Electrik Tel-O-Set system consists of a transmitter, receiver, controller & final control element. Complete details available.
24-25 *Minneapolis-Honeywell

Readout System.....Catalog 30B1000 describes a multiple-pressure readout system. Measures and records hundreds of different pressures simultaneously.
223C Fischer & Porter Co.

Temperature Regulator.... available in sizes ½" to 1½". Temperature ranges as low as 15 F. to 50 F.—as high as 240 F. to 350 F. Information in Bulletin 114 A.
32 *Manning, Maxwell & Moore, Inc.

Turbine Flowmeters.....Bulletin 1384 covers a new line of turbine flowmeters. Design and complete specifications. Special sections on operation and serviceability.
223D Cox Instruments Div.

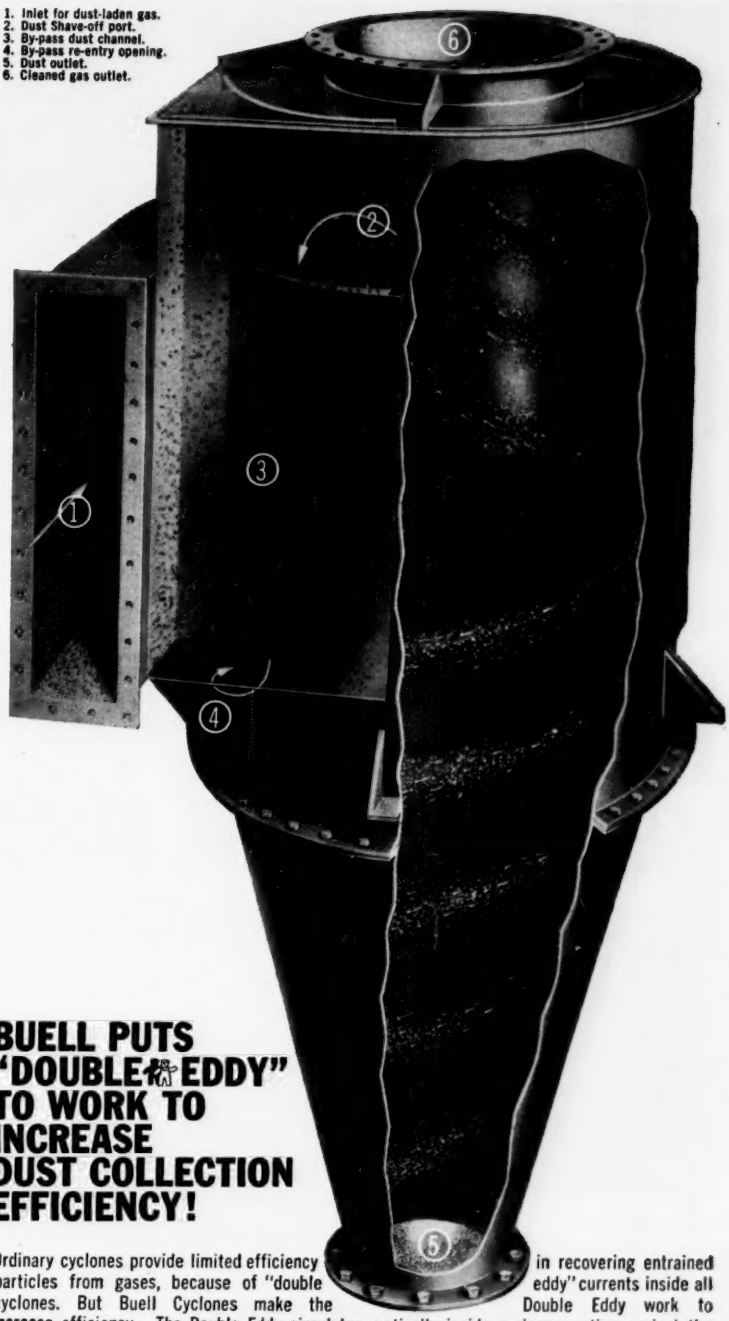
Pipe, fitting, valves

Duplex Tubes.....for such applications as chemical processing, refineries & food processing. Available in many alloy combinations to meet corrosive problems.
171 *Bridgeport Brass Co.

Ejectors.....Hydraulic, air & steam operated ejectors simplify handling of fluids, vapors, gases & hot materials; in a variety of standard & special designs.
222c *Penberthy Mfg. Co.

* From advertisement, this issue

1. Inlet for dust-laden gas.
2. Dust Shave-off port.
3. By-pass dust channel.
4. By-pass re-entry opening.
5. Dust outlet.
6. Cleaned gas outlet.

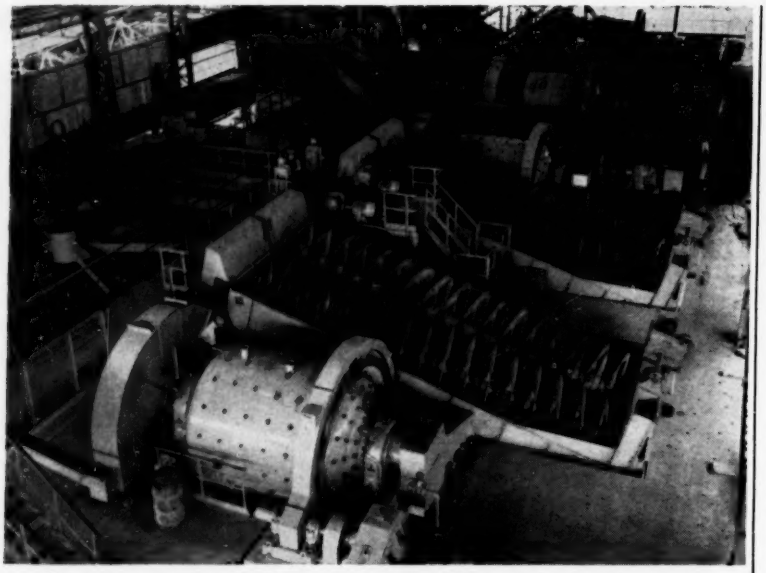


BUELL PUTS "DOUBLE EDDY" TO WORK TO INCREASE DUST COLLECTION EFFICIENCY!

Ordinary cyclones provide limited efficiency in recovering entrained particles from gases, because of "double eddy" currents inside all cyclones. But Buell Cyclones make the Double Eddy work to **increase** efficiency.—The Double Eddy circulates vertically inside cyclones, acting against the normal separating force of the spinning stream of dust and gas. Buell Cyclones have a narrow "Shave-off" port (2) at the top of the casing. This port catches and removes dust trapped in the Double Eddy. It makes the cyclone **more** efficient instead of less.—This is one of the reasons Buell has more experience with fluid bed catalyst recovery, for example, than all other manufacturers combined.—Only Buell Cyclones combine this high efficiency with large diameter. They will not clog or plug even with dust loadings up to one pound per cubic foot of gas. They can be made of any material. They can be completely lined, inside and out, against heat, corrosion and abrasion. No field fitting is needed: they are completely assembled and match-marked before shipment.—For a list of installations near you, a copy of our Catalog 103, or other information, call our nearest representative, listed in the telephone classified directories of most major cities under "Dust Collection Systems". Or write Dept. 12-J, Buell Engineering Co., Inc., 123 William St., N. Y. 38, N. Y. (Subsidiary: Ambuco Limited, London, England.)

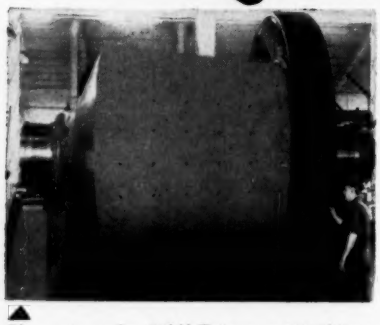
EXPERTS AT DELIVERING EXTRA EFFICIENCY IN DUST RECOVERY SYSTEMS: CYCLONES—"SF" ELECTRIC PRECIPITATORS—COMBINATION SYSTEMS—DRY CLASSIFICATION SYSTEMS.

buell®



Shown here are four Hardinge 9-3-6-8 Tricone Mills grinding sulfide copper ores and mixed ores in a concentrating plant in the Belgian Congo, Africa.

CORRECT BALL SEGREGATION
in the
Hardinge TRICONE MILLS

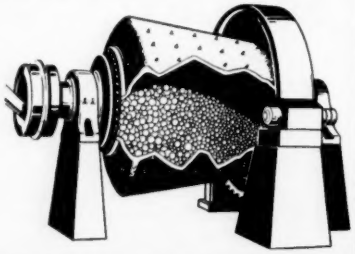


Shop view of a 10½′ Tricone with 9′ long tapered shell.

Highest grinding efficiency and lowest ball and lining wear are common to mills with a correctly segregated ball charge. The Hardinge Tricone Mill is the only mill providing these essentials to low cost operation without the use of special linings or internal devices, which are subject to wear and are effective through only a part of their wearing life.

The Tricone also occupies less floor space for its grinding volume than any other ball mill built.

Every ball in the Hardinge Tricone Mill "minds its own business!"



Complete specifications upon request. Bulletin AH-414-11.

HARDINGE
COMPANY, INCORPORATED

YORK, PENNSYLVANIA • 240 ARCH ST. • Main Office and Works
New York • Toronto • Chicago • Hibbing • Houston • Salt Lake City • San Francisco • Birmingham • Jacksonville Beach

LITERATURE . . .

Expansion Joint.....Compact bulletin is intended as a brief digest of information on the nomenclature and selection of the manufacturer's joints. Guide for application.
224A Badger Mfg. Co.

Pipe.....Saran Lined Pipe, fittings, valves & pumps are available for systems operating from vacuum to 300 psi, from below zero to 200 F. Information available.
78 *The Dow Chemical Co.

Pipe, Fittings, Valves.....Catalog 356 contains details including charts, diagrams & illustrations on jacketed piping, fittings, plug valves, joints, etc.
224B Parks-Cramer Co.

Pipe, Polyvinyl.....for a variety of uses in the chemical industry. Resistant to many chemicals, including acids, alkalies, salt solutions & alcohol. Bul. 24.
92 *U. S. Steel, National Tube Div.

Sanitary Fittings, Valves.....Catalog lists a complete line of stainless steel sanitary fittings and valves. Specifications, drawings and photographs. Also pumps.
224B Cherry-Burrell Co.

TeeLet.....available in sizes from ⅛ to 1½″ IPS. TeeLets are fully machined from forging quality solid steel bars & adapt to run-pipe sizes to 36″. Details.
194 *H. K. Porter Co., Inc.

Tubing.....New AX tubing is available in Bronze, Stainless Steel & other metals & alloys from 4½″ I.D. to 14″ I.D.—to handle axial & lateral movement.
106 *The American Brass Co.

Tubing.....Stainless Steel tubing with uniform mechanical properties & dimensions for ease of bending, welding or other fabrication. Full information in Bul. TB-355.
122 *The Babcock & Wilcox Co.

Valve.....Full opening Union Check type allows free passage of product separating or line cleaning devices. Fits 2″ diameter pipe. Rated 500 P.S.I.-W.O.G.
117 *Clayton Mark & Co.

Valve, Needle.....Improved with fabulous "Teflon" packing. Now enables the needle valve to stand up & work right under pressures up to 10,000 psi. Facts.
TL225 *Marsh Instrument Co.

Valves.....Information on the complete line of Rotovalves & butterfly, ball and wafer valves is available. Rangeability is greater than 150 to 1.
224C *Allis-Chalmers, Hydraulic Div.

Valves.....Bulletin A-155 gives complete data on company's line of valves for a wide variety of nuclear and chemical application. Diagrams and charts included.
224D Associated Valve Co.

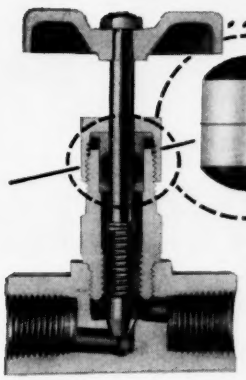
Valves.....Bulletin features application and specification details of TA Series Globe & Angle Valves. Lists over 100 different fluids controlled by this series.
L230a *The Bastion-Blessing Co.

Valves.....Positive shut-off is assured by pressurized lubricant sealing between the valve plug & the body. Complete line of lubricated plug valves. Booklet V-203.
113 *Rockwell Mfg. Co.

* From advertisement, this issue

"...yet we have IMPROVED it"

The Marsh Stainless Steel Needle Valve could have gone right on being the finest in its field...yet we have improved it



...with fabulous "TEFLON" packing

Note the "close-up." The Marsh Marpak packing system, originated in the Marsh Needle Valve, was one of the factors that has enabled it to stand up and work right under pressures up to 10,000 psi.

Now "Teflon" is used in this packing system—the miracle material of almost incredible *toughness, resilience* and *non-adhesive* properties...properties that are not impaired by the most powerful of solvents, acids, or alkalies even at temperatures *up to 500° F.*

Net result: The guaranteed application-range (up to 10,000 psi) is now effective at any temperature up to 500° F. (In other makes, permissible temperature decreases as pressure increases.)

Marsh Marpak Teflon Packing System is standard in Marsh 416 Stainless Steel Needle Throttling Valves. Ask for facts.

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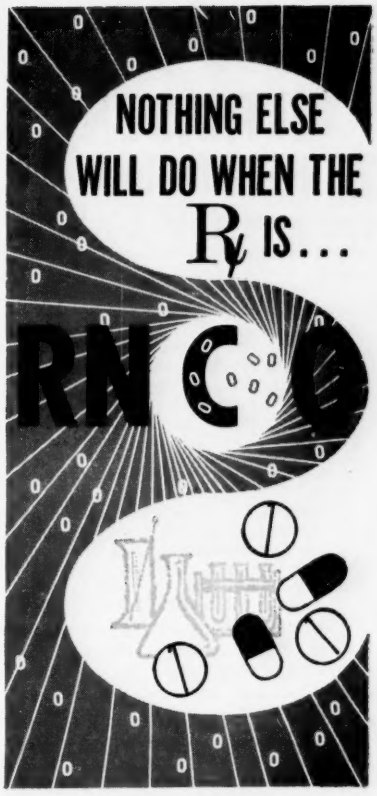
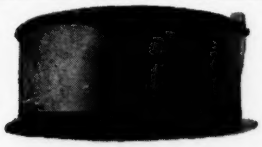
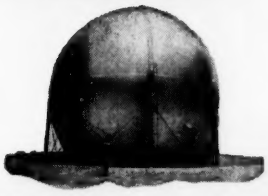
Needle Valve in 416
stainless steel throughout
Now with "Teflon" Packing

MARSH INSTRUMENT COMPANY, *Division of Colorado Oil and Gas Corporation,* Dept.24, Skokie, Ill. • Marsh Instrument and Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta • Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas







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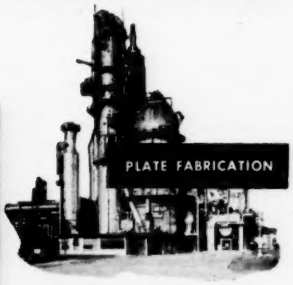

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Thus another happy marriage of chemistry and engineering and...a little more grist to our mill.

..in Adhesives ultrasonics puts stickem in adhesives, too. Apparently someone who was frustrated as a child pasting with flour and water finally developed a really sticky adhesive. But his success story stuck in his customers' mind only after he ran it through the Rapisonic. Result: the finest texture and stickiest film yet.

Sonic Homogenizers develop and use all the energy right in the liquids with only 1/6 to 1/10 the power, and at a fraction of the first cost, of conventional equipment . . . maintenance-negligible.

The Minisonic...for small batches

Other Models

RAPISONIC ...production homogenizer

SANISONIC ...meets sanitary requirements

AUTOSONIC ...continuous supply

DISPERSONIC ...abrasive emulsions

Sonic homogenizers can give you a superior emulsion, too. Send for technical bulletin

Sonic

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146 Selleck Street, Stamford, Conn.

LITERATURE . . .

Valves.....Non-lubricated Ball Valves feature full bore conduits, Teflon stem gaskets & seats that are sealed from the lading flow. Sizes ½" through 6". Cat. 1000.
53 *W-K-M Div. of ACF Industries

Valves, Control.....New 20-pg publication lists valve bodies & actuators and the accessory line available for control valves. Valve sizing data included in Bul. 150.
226A DeZurik Corporation

Valves & Fittings.....have high burst strengti.. All parts made of plastic. Newest literature on the complete line of PVC Valves & Fittings is now available.
124 *Walworth

Valves, Gage.....feature exclusive "floating shank" which saves on installation, eliminates strains common to forced installations. Special valves & accessories.
222b *Penberthy Mfg. Co.

Valves, Metal.....offer balanced corrosion-resistance. Full details on the maintenance-saving features of "Causul" Metal Valves is available on request.
109 *The Lunkenheimer Co.

Process equipment

Blender.....A blender for the controlled measurement and blending of two liquids is the subject of a new bulletin. Liquids may have dissimilar properties.
226B B-I-F Industries

Blender.....New centrifugal Liquid-Solids blenders sizes range from laboratory models to 50 cu. ft. capacity. Information on blenders & Vacuum Tumble Dryers offered.
38-39 *Patterson-Kelley

Chemical Feeders.....give accurate, dependable metering of chemicals, acids, oils & other liquids. Wide range of capacities, feeds & delivery rate. Catalog.
B232 *Manzel

Centrifugal, Continuous.....offers separating force ranges from 30 to 3000 gravities & capacities range from 200 lbs. to 120,000 lbs. per hour.
2 *Bird Machine Co.

Centrifugals.....Batch-O-Matic can handle highly corrosive materials under exacting standards of purity. Ilustrated details plus information on Tolhurst machines.
241 *American Machine & Metals

Centrifugals.....Bulletin 356 contains complete information in Reineveld centrifugals. Reineveld 51" automatic centrifuge gives lower moisture.
T210 *Heyl & Patterson, Inc.

Centrifuge.....The C-41 Super-D-Hydrator offers advanced design for high capacity deliquefication of inorganic & organic solids. Details in Bul. 1286.
91 *The Sharples Corp.

Crusher, Saw Tooth.....Its hard faced 16" diameter breaker saws are designed specifically for the reduction of tough or brittle materials. Specification Sheet No. 204.
26a *Sprout-Waldron

* From advertisement, this issue

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Dura Seal is the most extensive line of mechanical seals offered to industry today . . . meeting a wider range of pressures, temperatures and liquids.

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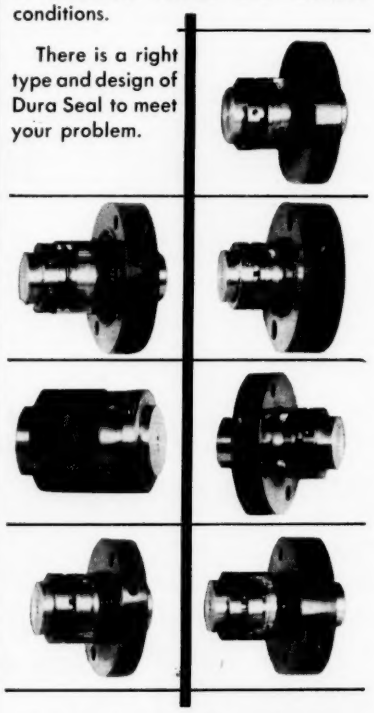

For further details, write for free copy of Catalog No. 480 CE

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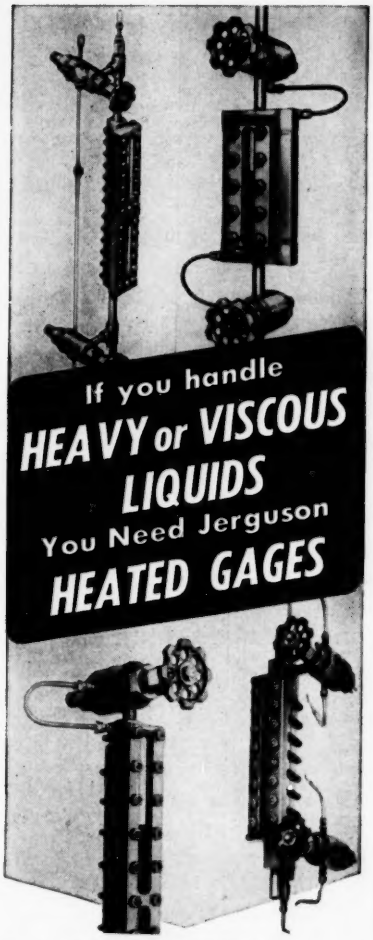

In the COMPLETE LINE of Jerguson Heated Gages there is a model to meet your specific needs . . . heated by steam or electrically

You can accurately gage heavy or viscous liquids with Jerguson Heated Gages . . . and the line is so complete there is a model to meet your specific problem. Made in Reflex or Transparent styles, in External or Internal Tube models, as well as a large chamber model with dual tubes. Heated by steam, hot fluid, or electrically. Furnished with special jacketed heated-gage valves, union or non-union connections. You get accurate, dependable gaging of heavy or viscous liquids, or protection for cold weather installations.

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Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

LITERATURE . . .

Crushing Rolls.....reduce soft to hard 2" & smaller materials to from 12 to 20 mesh with minimum fines. Eight sizes, with rolls from 8 x 5" to 38 x 20". Bul. 065.
R221c *Sturtevant Mill Co.

Cyclones.....will not clog or plug even with dust loadings up to one pound per cubic foot of gas. They can be made of any material. Details in Catalog 103.
233 *Buell Engineering Co.

Dry Processing Equipment.....Catalog illustrates and describes a full line of dry processing equipment. Air separators, blenders, mixers, crushing and grinding mills, etc.
227A Sturtevant Mill Co.

Dryers.....with proven high-level production, minimum of maintenance requirements, fast installation & low erection costs. Complete details are available.
16 C. G. Sargent's Sons Corp.

Dust Control.....Bulletin W-7456 describes UW-4 Dynamic Wet Dust collectors and UW-4 Washers. Washers are self-cleaning & fire & explosion proof.
R230 *The Ducon Co.

Dust Control.....New data and information on dust control via cyclone separators is offered by manufacturer. Specifications, drawings and multiple rating tables.
227B Torit Mfg. Co.

Filter.....Model MCRS filter is completely automated for continuous operation unattended. Capacities up to 1000 sq. ft. of filtering surface. Details.
182 *Sparkler Mfg. Co.

Filter, Dust.....Complete specifications, typical equipment layouts, capacity & performance of the Reverse Jet Dust filter are contained in Bulletin F-75.
204 *The Day Company

Filter Press.....can handle most filterable mixtures & most filter media. Catalog includes details of Sperry's Plate-Shifters, Closing Devices & other accessories.
217 *D. R. Sperry & Co.

Filter Presses.....available with plates & frames of Fiberglass-reinforced polyester, Havag, rubber, impregnated wood, & metal covered with PVC, other plastics & rubbers.
BL221 *T. Shriver & Co.

Filter Systems.....Bulletin #F103 describes the advantages of Dulaire jet-cleaned filter systems. They collect dust from industrial processes. No down time for cleaning.
180 *Western Precipitation Corp.

Filters.....Fulflo filters are available in a wide range of models for high or low flow rate, pressure, viscosity, pH or temperature. Technical literature is available.
76 *Commercial Filters Corp.

Filtration.....A complete line of filter types: positive self-cleaning edge-type, automatic self-cleaning wire wound, disposable depth cartridge, porous metal, screen mesh.
71 *The Cuno Engineering Corp.

Filtration.....The "Filter Media Selection Chart" giving corrosion and temperature factors for all known media—is a valuable reference to have in hand.
R229 *Purolator Products, Inc.

* From advertisement, this issue

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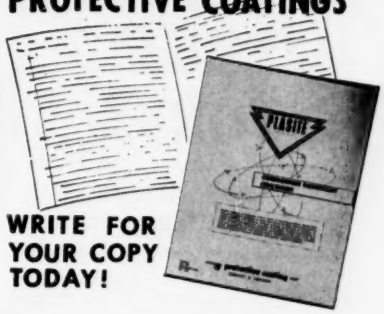
YOUR SELECTION OF PROTECTIVE COATINGS



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By entrusting such work to ROLOCK, you gain the many advantages of competent engineering supervision; production personnel thoroughly experienced in the problems and materials involved; a modern plant fully equipped for inspection and testing as well as fabrication.

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VIKING PUMP COMPANY

Cedar Falls, Iowa, U.S.A. In Canada, it's "ROTO-KING" Pumps

See our Unit in Chemical Engineering Catalog

LITERATURE . . .

Gas Scrubbers.....Design simplicity makes it possible to utilize materials resistant to corrosion, abrasion or high temp. Brochure with data on Venturi scrubbers.
33 *Chemical Construction Corp.

Generator, Hyni Nitrogen.....Bulletin No. 197 describes the generator & how it works. Also covers the advantages of the process and a table of sizes.
228A Lindberg Engineering Co.

Hammer Mills.....reduce to 20 mesh. Bulletin No. 084. covers Swing-Sledge Mills, Hinged-Hammer Pulverizers and Four Swing-Sledge Mills, etc.
R221d *Sturtevant Mill Co.

High-Vacuum Stills.....A complete family of high-vacuum stills, spanning range from research to production items is covered by new bulletin. Rates to 2,000 lb./hr.
228B Consolidated Electrodynamics

Homogenizers.....develop & use all the energy right in the liquids with only 1/6 to 1/10 the power. Technical bulletin now available covers all the models.
L226 *Sonic Engineering Corp.

Hydrogen Generators.....New line of packaged hydrogen atmosphere generators is described in detail in a new bulletin. Comprehensive flow chart and tables.
228C Gas Atmospheres, Inc.

Impact Mill.....for finer & more intimate dispersion of solids. Literature on Impact Milling, and Particle Size Reduction etc.
TL229.... *Entoleter Div., Safety Industries

Jaw Crushers.....Eight models range from 2 x 6 in. jaw opening (lab model) to 12 x 26 in. Capacities to 30 tph. Further information in Bulletin No. 062.
R221a *Sturtevant Mill Co.

Mills.....Tricone Mills feature correct ball segregation. Also occupies very little floor space for its grinding volume. Complete specifications in Bul. AH-414-11.
224 *Hardinge Co.

Mills, Impact.....Bulletin tells most efficient method of achieving particle size reduction by centrifugal force. Available in all sizes for any requirement.
228D Safety Industries, Entoleter

Mixer.....New Model RL Hi-Shear offers finer, faster blending, dispersing & homogenizing. Features controllable flow pattern. All parts stainless steel. Information.
207 *Gabb Special Products, Inc.

Mixers.....The complete line of fluid mixers range from fixed-mounted 40 H.P. turbines & heavy-duty propeller mixers to lightweight portables. Handbook offered.
219a *Eastern Industries, Inc.

Mixers, Side-Entering.....Handles the extra heavy-duty jobs in big tanks. Available in sizes ¼ to 30 H.P. Complete information in Bulletin 620.
219b *Eastern Industries, Inc.

Mixers, Top-Entering.....Designed for heavy-duty applications requiring agitators from ¼ to 10 H.P. Bulletin No. 620 gives the complete story.
219c *Eastern Industries, Inc.

* From advertisement, this issue

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- **Centrifugal Impact Mills and Mixers**

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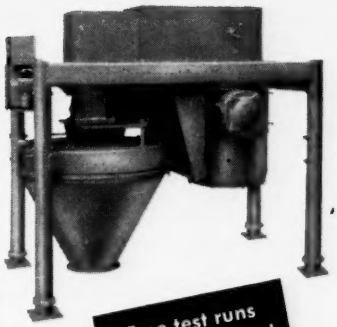

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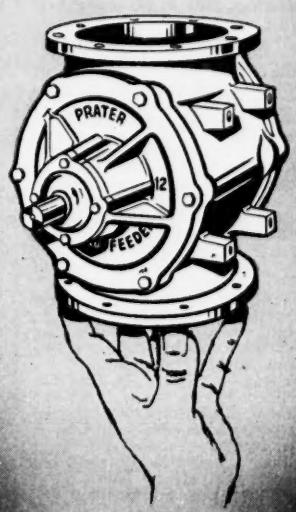


WRITE FOR BULLETIN P58

PRATER PULVERIZER COMPANY
1517 South 55th Court • Chicago 50, Illinois

a filter man's thinking

FORESIGHT: Developing the solution before the problem comes up

It takes a long time to translate the need for a new aircraft into an actual piece of flightworthy hardware. It can take forever — if its special operating requirements can't be met by known materials and components. Few jets would be in the air today if certain industrials — like Purolator — hadn't recognized that difficult operating conditions had to be anticipated long in advance.

A modern aircraft has a maze of circulatory systems: fuel, air, lubrication, pneumatic, and hydraulic lines . . . instrument systems, etc. — with filters playing an important role in each. In high performance jets extremes of temperature, pressure, flow and structural strain . . . and the need to handle chemically-active fluids . . . preclude the use of the kinds of filters which had proved adequate for older aircraft. To fill the gap, our engineers some years ago developed Purolator's famous porous metal filter medium. This type of filter has since been brought to a high degree of efficiency.

Purolator makes these media by a unique method of fusing metal powders of controlled particle size to obtain the desired porosity. The metals used are matched to specific service requirements — and include all grades of stainless steel, nickel, monel, Inconel, Hastelloy, bronze, gold, silver, etc.

We can fabricate these media into almost any shape you care to name. We can control pore size to within 10% even when down as small as 0.2 microns. We can sinter the elements to fittings of the same or other materials. We can vary wall thickness from .015 inches up. We can apply thin layers of porous metal to other types of media. We can squeeze 500 square inches of filter area into an element 3½ inches in diameter and 10 inches long.

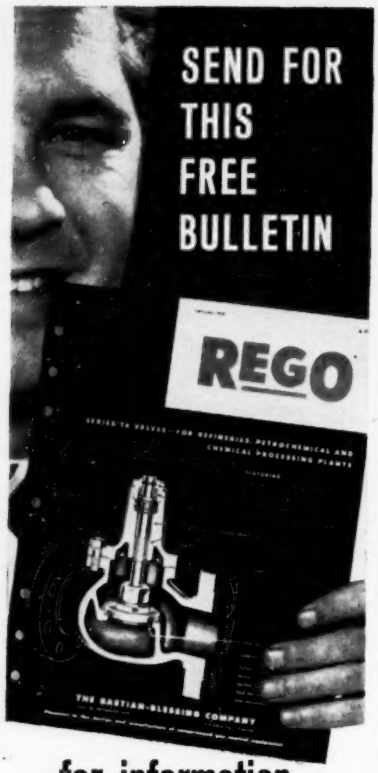
Many of these filters can withstand pressures up to 6000 psi . . . temperatures from –420° to 1200°F...severe corrosive environments. In addition to aircraft, they're being widely used in chemical, nuclear, petroleum and other industries — for filtration, contamination control, separation of liquids, and diffusion applications.

"Filter Media Selection Chart"—giving corrosion and temperature factors for all known media—is a valuable reference to have on hand. Write us—it's yours free.

Jules P. Kovacs
Jules P. Kovacs, V. P.

Filtration For Every Known Fluid

PUROLATOR
PRODUCTS, INC.
Rahway, New Jersey and Toronto, Ontario, Canada



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Features application and specification details for outstanding TA Series Globe and Angle Valves. Permanently leakproof – no packing to adjust or cause binding of stems: have exclusive Teflon V-Ring Pressure Seal, providing positive leakproof stem seal; Teflon Seat Disc for long life. Rugged Ductile Iron body. Bulletin lists over 100 different fluids that can be controlled by TA Series Valves.

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FREE LITERATURE

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- ☐ Relief Valve Manifolds
- ☐ Liquid Oxygen Relief Valves
- ☐ High Pressure Gas Regulators
- ☐ High Pressure Cylinder Manifolds

LITERATURE . . .

Mixers, Turbine.....Bulletin 1210 contains details on these turbine mixers which solve many special mixing problems. Available in a range of ¼ to 40 H.P.
219d *Eastern Industries, Inc.

Mixers.....You'll find a wealth of information on fluid mixing in bulletins describing Lightnin Mixers. Condensed catalog shows all types. No. B-109.
246a *Mixing Equipment Co., Inc.

Mixers.....Model "LF" Mix-Muller has capacity of ¼ to ¾ cu. ft. Has machined crib & mullers; discharge is automatic by bottom door. Complete details offered.
57 *National Engineering Co.

Mixers, Centrifugal.....New principle of high speed mixing producing intimate dispersions covered in bulletin.
230A Safety Industries, Entoleter Div.

Process Equipment.....Modern fabrication facilities are available for construction of a single unit or an entire plant. Catalog E-60 contains 48 pages of data.
159 *Acme Process Equipment Co.

Processing.....Flomix combines liquids, solids & liquids, or gases & liquids which in combination, will readily flow through piping. Bulletin 531A.
55 *Nettco Corporation

Processing Equipment.....Equipment for pulverizing, fiberizing, granulating and blending various materials is covered in Bulletin 59. Also pulp and paper items.
230B Bauer Bros. Co.

Processing Equipment.....Catalog 386 "Buflovak Processing Equipment" outlines the sound research, export engineering, on-schedule delivery & customer service.
82-83 *Blaw-Knox Co.

Rotary Airlock Feeders.....Bulletin P58 contains complete information on Rotary Airlock feeders for dust control and a section on pneumatic conveying.
BL229 *Prater Pulverizer Co.

Rotary Fine Crusher.....reduce soft to medium hard 3 to 8" material down to ¼ to 1¼" sizes. Capacities up to tph. Non-clogging operation. Bul. 063.
R221b *Sturtevant Mill Co.

Screens, Vibrating.....Important new design, compact, high capacities, low power requirements for long life. Available in all sizes.
230C Safety Industries, Entoleter Div.

Sifters.....Super active ball cleaning device provides rebound points in each ball compartment, assuring fast, thorough sifting of your product. New ro-ball bulletin.
183 *The J. H. Day Co.

Spray Nozzles.....Information is now available for each of the hundreds of spray nozzles. Data on material dimensions, flow rate, pressure angle of spray, etc.
202 *Spray Engineering Co.

Stream Splitters.....Complete facts on the line of precision stream splitters is now available. Bulletin 137-B contains all the details on operation, etc.
26b *Sprout-Waldron

* From advertisement, this issue

DUCON DYNAMIC WASHERS

RECOVER DIFFICULT DUSTS EFFICIENTLY AND ECONOMICALLY

Ducon UW-4 Dynamic Wet Dust Collectors have added a new dimension in dust recovery. They have replaced, with outstanding success, many more costly and less effective dust collectors in the recovery of "difficult" materials, such as fine and abrasive dusts in kilns, rotary driers and other applications.

The UW-4 Washers are also ideal for high loading conditions where maximum efficiency is desired.

Ducon UW-4 Washers offer other unique advantages, including constant air capacity, low water consumption and rugged construction. They are self-cleaning and fire and explosion proof.

Send for Bulletin W-7456.

DUCON — DUST CONTROL SYSTEMS AND EQUIPMENT

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THE **Ducon** COMPANY INC.

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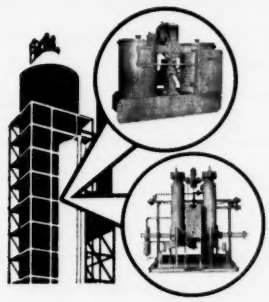
FOR INDUSTRY . . .



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The MACK IRON WORKS COMPANY
132 WARREN STREET
WRITE TODAY FOR CATALOG A-9

LITERATURE . . .

Pumps, fans, compressors

Corrosion-Resistant Fans.....Resin-bonded fiber glass fans, ranging in size from 6- to 34-in. inlet are described in booklet. Complete capacity rating tables.
231A Du Verre, Inc.

Centrifugal Pumps.....A series of ten steel-case centrifugal pumps in a wide range of sizes are described in a new bulletin. Capacity range to 6,400 gpm. Heads to 3,200 ft.
231B Goulds Pumps

Duct Fans.....New line of fiberglass belt-drive duct fans is discussed in Bulletin A-116. Fans are available in 20-, 24- and 28-in. diameters. Low in cost.
231C Hartzell Propeller Fan

Fan.....Type "BL" fan for supplying ventilating, airconditioning & air cleaning systems. Complete information is contained in Bulletin F-104.
1 *Buffalo Forge Co.

Gear Pumps.....Bulletin G-1 describes a line of herringbone gear pumps. Units specially designed for long life in difficult applications. For viscosities to 10 million SSU.
231D Schutte & Koerting

High-Pressure Pumps.....Bulletin gives data on hand-operated, motor-driven and air-operated pumps. Information on uses of items in high-pressure work.
231E Autoclave Engineers, Inc.

Proportioning Pump.....New bulletin describes Model 1106 Adjust-O-Feeder, a pump designed for the accurate proportioning of general industrial fluids.
231F B-I-F Industries

Pump.....Centri-Chem pumps feature type 20 stainless steel throughout the casings, shafts & impellers, meeting a wide range of corrosion services. Bul. CT-859.
114a *ECO Engineering Co.

Pump, High Pressure.....Design features of the H X pump & how it works are covered in Bul. HX-57. Also details of bag diaphragm operation, dimensions & spec.
231G Manton-Gaulin Mfg. Co.

Pumps.....for handling corrosive and hazardous processing fluids. Literature on All-Chem & Manilab rotary pumps, Gearchem gear pumps, Gear-Vac valves, etc.
114b *ECO Engineering Co.

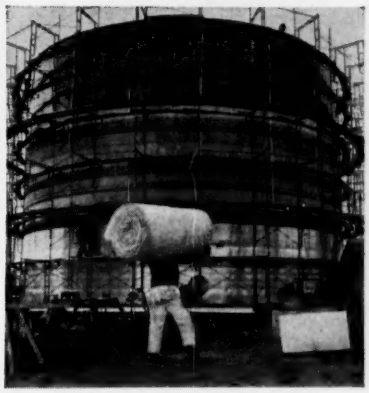
Pumps.....Types DL & DM offer capacities up to 1000 GPM & working pressure up to 300 PSIG. Head range to 430 ft. & temperature range to 430 ft. & temp. to 450 F.
105 *Food Mach. & Chem. Peerless Pump

Pumps.....Heavy-Duty type made of stainless steel, monel, mild steel & other alloys can be operated up to 100% rated speed on thin liquids. Catalog MC.
B228 *Viking Pump Co.

Pumps.....A choice of metal or rubber impellered pumps for capacities from 0 to 300 GPM. More than 500 positive displacement pump combinations available.
165 *Waukesha Foundry Co.

* From advertisement, this issue

Save with G-B insulations



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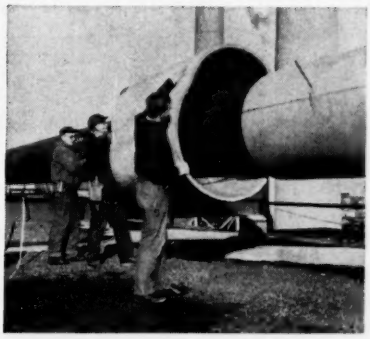

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GUSTIN gb BACON

GUSTIN-BACON Mfg. Co.
252 W. 10th St., Kansas City, Mo.

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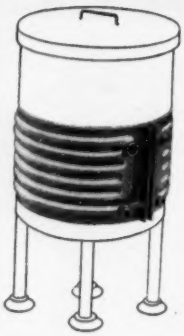

In previous issues you have seen the Drum Warmer shown small, below. The Clamp-On Type at the left is similar — but on legs. The Dean Thermo-Panel Coil warms and cools ALL designs and sizes. No electrical spark or flame hazards. Safe. Simple. Economical.

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author

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tar'i-an-ism (ô-thôr'i-târ'i-an
au-thor'i-ta'tive (ô-thôr'i-tā'ti
from, authority; entitled to ob
thoritative teachings. 2. Ha
peremptory. — au-thor'i-ta'tiv
au-thor'i-ty (ô-thôr'i-ti), *n.*; *p*
auctoritas] 1. Legal or righ
a particular field; as, the Port
to, in support of opinio
ony; witness. b A prec
or author. d Just
influence of
like. — Syn.
ô-thôr-i-zā'shən
(ô'thôr-īz), *v. t.* 1
commission; as, *autho*
act.
und for. — au'th
a'thor-ized (ô'thôr-īzd), *adj.* a
hority. b Sanctioned or appro

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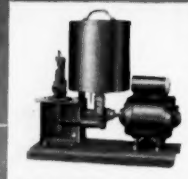

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LITERATURE . . .

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245 *A. R. Wilfley & Sons, Inc.

Pumps, Sump.....Available in automatic, electric, explosion-proof, submersible & standard types in 8 models & 20 sizes. Literature & specific engineering data offered.
222d *Penberthy Mfg. Co.

Rubber Impellers.....Catalog sheet covers rubber impellers for self-priming pumps. Precision-molded units have a service life up to 1¼ times longer than standard ones.
232A Pacific Moulded Products

Turbine Pumps.....Bulletin covers line of ultra-high-flow vertical turbine pumps. Latest addition to line is a submersible model having motor on bottom end of shaft.
232B Worthington Corp.

Vacuum Blowers.....New line designed to handle capacities ranging from 30 CFM to 1,000 CFM. Specification sheet on new series & Bul VP-158 covers larger units.
73 *Roots-Connersville Blower

Services & miscellaneous

Chemical Goggles.....AO Flexible Mask chemical goggles offer light weight, optical fidelity & better ventilation. Feature wide angle vision & excellent fit.
98 *American Optical Co.

Emergency Showers.....Catalog fully illustrates and describes multi-spray emergency shower with swinging-gate actuator. Models for field or plant use.
232C Logan Emergency Showers

Engineering Services.....“The Plant You Want To Build” is the title of a brochure that details the character and range of services offered by Foster Wheeler.
232D Foster Wheeler Corp.

Filter Paper.....“Netone” offers high tensile strength & high burst factor. Also abrasion, crease and chemical resistance. Free samples are available for testing.
192 *National Filter Media Corp.

Fire-Fighting Equipment.....Brochure describes and illustrates all types of portable fire extinguishers, wheeled units, built-in systems and fire detection devices.
232E Walter Kidde & Co.

Laboratory Equipment.....32 p. revision in catalog “Scientific Apparatus & Methods,” Vol. 11, No. 2, Section 1, covers oil stability apparatus, analytical ovens, balances.
232F E. H. Sargent & Co.

Laboratory Sinks.....Durcon sinks are light in weight & have coved corners & dished bottoms to prevent accumulation of contaminants. In 14 standard sizes. Bul. PF/5.
175 *The Durron Co., Inc.

Sewage Treatment Plants.....Bulletins describe packaged sewage treatment plants. Simplicity of operation and nuisance-free effluent are among features of the units.
232G Walker Process Equipment

* From advertisement, this issue

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1—Sargent Dryer, apron 90" wide, 7 fans with Feeder
1—Stainless Steel Pressure Tank with 2 Vacuum Pumps 48" dia. 58" deep with SS basket
2—½ HP Lightnin Mixers, 550V, (1 new)
5—General Heat Exchangers 300# test, W.P. 150#
1—Parsons Engineering Dust Collector, 64 Bags with Syntron Elec. Vibrators
1—Robinson Blender Size 0 and Robinson Shaker Size 13
2—Steel Storage Tanks 13'x8' dia. each with Syntron Elec. Vibrator with one Rotor Lift
4—Formaldehyde Rubber Lined Tanks 5000 gal. each, with rubber lined fittings
2—Sulphuric Acid Tanks,
1—66" dia. x 12 ft.
1—96" dia. x 25 ft.
1—Shriver #12 Filter Press
3—Shriver #24 Filter Presses
1—Lixator Brine & Storage Tank with bucket elevator
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Dopp 350 gal. cast iron Jack. Vacuum.
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Hammer Mills & Pulverizers 3 to 50 HP.
Rotary Cutters 1½ to 5 HP. & up.
Spr. Waldron Stainless spike crusher.
Pebble, Jar & Ball Mills, Lab. to 6' x 8.
3 Roll, 9" x 32", 12" x 30", 16" x 40".
Lehman 4 Roll W.C. 12" x 36" Steel.
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Mixers: Baker Perkins Jack. 100 gals.
Day Imperial 75 & 150 gals.
Change Can Mixers 8, 15, 40 gals.
Day Jumbo 700 gal. horiz. mixer.
Sturtev. 1 ton Drum Blender 10 HP.
Blystone 3000# horiz. spiral mixer.
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Gould 75 HP. Centrifugal 250 PSI.
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1—Bird 36" x 50"', 347 S.S. Solid Bowl Continuous Centrifuge.
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1—Sharples H2 Nozzlejector, 15 HP, 304 S.S.
1—Bird 40" suspended, 347 S.S. perforated basket.
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1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaporite housing.
1—Sparkler 332528 Filter, 150 sq. ft. 304 S.S.
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1—Baker Perkins #16TRM, 150 gal. jktd., Vac. 60 HP.
1—Baker Perkins 100 gal. jktd., Sigma Blades.
5—Day "Cincinnatus" double arm, 250 and 100 gal.
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Tolhurst 26" Rubber covered perforated Basket Centrifuge. 5-2-½ HP, 1200/660 RPM
Western States 30" S.S. underdriven perforated basket Centrifuge. Vaportite. 15 HP.
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For immediate quote, wire or phone collect—GA 1-1380

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1—Roberts, Model UD-3620, under-driven, bottom discharge, vapor tight centrifugal machine. Manufactured by the Western States Machine Company. Type 316 S.S. on all contact surfaces. Complete automatic recycling operation. Perforated basket 36" dia. x 20" high x 5½" cap. Volumetric capacity 6.1 cu. ft. Controls, drive motors, discharge motor, Class I, Group D. D.C. power unit is a G.E. Speed Variator. USED

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Dryers: Link-Belt Monotube of monel.
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Kettles: St. Steel, with and without ag. Dopp 150 gal. dbl. act. agitator.
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Hammer: Williams, Jeffery, Prater, Ray.
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3—Sharples PN14 Super-D-Canters, 316 S.S.
1—AT&M 26" sus. Cent., perf. bskt., 316 S.S.
1—Oliver 8' x 8' Precoat rubber covered Rotary Vacuum Filter.
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1—Link-Belt #310-20 roto-louvre dryer, 3'10" dia. x 20' long.

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3—3500 gal. T316 SS, jkt. & agit.
2—2250 gal. T316 SS, jkt. & agit.
1—2200 gal. T316 SS, jkt. & agit., VAC.
1—1300 gal. T304 SS, jkt., 5 HP XP agit.
3—750 gal. T304 SS, jkt. & agit.
1—500 gal. T304 SS, jkt. & agit.
6—465 gal. T304L SS, jkt. & agit.
1—350 gal. T304 SS, jkt. & agit.
2—125 gal. T316 SS, jkt.

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1—11' x 155' Traylor, 7/8" shell Kiln.
1—9' x 100' Vulcan, 3/8" shell Kiln.
1—8' x 125' Kiln, 5/8" shell.
1—8' x 115' 5/8" shell, 2-tire Kiln.
2—7'6" x 100' 1/2" shell Kilns.
1—7'6" x 60' Kiln, 1/2" shell.
4—Hardinge 8'8" x 70' dryers, 5/8" shell.
1—7'6" x 60' dryer, 1/2" welded shell.
1—Allis-Chalmers 7' x 50' dryer., 5/8".
1—6' x 50' Louisville dryer.
6—Steel dryers: 5'6" x 50', 4'9" x 32', 4'6" x 40', 4' x 30', 3' x 15'.
2—Stainless dryers: 4'6" x 12', 3' x 10'.

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12—4500 gal. nickel-clad, vert. 125#.
1—3000 gal. alum., vert., open.
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2—5700 gal. T304 SS, horiz., UNUSED.
4—Vacuum tanks w/coils, T304 SS: 3700, 3000, 2350, 1750 gal.
1—3400 gal. T304 SS, horiz.
1—2000 gal. T316 SS, hopper.
8—1750 gal. T304 SS, hoppers.

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1—Sharples #PN-14 Super-D-Canter, T316 SS, vapor-tite.

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2—American T316 SS blowers, 5600 cfm, 50 HP.

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1—Alco 110 sq. ft. pressure leaf filter, T316 SS.
11—Struthers-Wells vacuum crystallizers, 1200, 560 gal., T316 SS, cone bottoms.
1—Elmco T304 SS rotary vac. filter, 18" dia. x 24" face.

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25—Copper & Cupro-Nickel heat exchangers & condensers, up to 1070 sq. ft.

TYPE 316 SS KETTLES

2—3,500 gal. Struthers-Wells vert., 7' dia. x 12' high, jacketed, int. coils, 40/20 HP agit.
1—2,830 gal. horiz. still kettle, 6' x 12' 100 sq. ft. int. coil.
2—2,250 gal. vert., 7' dia. x 6'3" high, jacketed, 3 HP, agit.
1—2200 gal., 6'6" x 8', vacuum, jacketed, agit.

TYPE 316 STAINLESS STEEL TANKS

1—17,650 gal. horiz., 9' dia. x 36' long, 1/4" shell, 3/8" dished heads.
1—8,500 gal. vert., 8' x 21'6", dished heads, int. coil.
1—2,830 gal. horiz., 6' x 12', 5/16 shell & dished heads, VACUUM.
3—2,750 gal. vert., 7' x 8', dished heads, int. coils.
9—2,300 gal. vert., 7' x 8', int. coils, (some w/agit).
5—2,250 gal. vert., 7' x 6'3", dished heads, (some w/agit., some w/jacket).
2—1,900 gal. vert., 6' x 8', 3/8" shell & dished heads, VACUUM.
4—1,200 gal. vert., 5' x 7', dished top, cone bot., VACUUM.
6—685 gal. vert., 3' x 13', internal coils.
1—575 gal. vert., 4' x 6', dished heads, int. coil.
7—560 gal. vert., 3'6" x 7', dish top, cone bot., VACUUM.
50—Tanks & pots, 30 to 500 gal., T316 SS.

COLUMNS—STAINLESS STEEL

1—110" dia. Vulcan, 10 trays—bubble caps, T316 SS.
2—96" dia. Vulcan, 30 trays—bubble caps, T316 SS.
1—96" dia. Vulcan, 10 trays—bubble caps, T316 SS.
2—60" dia. Vulcan, 10 trays—bubble caps, T316 SS.
1—48" dia. Vulcan, 25 trays—bubble caps, T304 ELC SS, 100 PSI
3—24" dia. Vulcan, 12 trays—bubble caps, T316 SS—VACUUM.
6—T316 SS Packed Columns: 42", 36", 30", 24", 20" dia.
5—Steel Packed Columns: 60", 48", 36", 30", 20".

COLUMNS—COPPER

5—Vulcan copper bubble-cap columns, VACUUM! 72" x 40 plate; 48" x 25 plate; 48" x 22 plate; 24" x 20 plate.

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10,000—T316 SS pipe, schedule 40, 10, 5, sizes 1/2", 1", 1 1/2", 2" up to 12".
50—T316 SS pumps, sizes from 6" x 5" to 1" x 1".
1—Otis elec. freight elevator, 5000# capacity @ 75 FPM.
2—Stainless steel reboilers.
2—Stainless steel bucket elevators, 60' & 40' high.
1—2,100 gal. vert. alum. tank, coils.
10—T316 SS separators, 22" x 8' deep.
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3—18,000 gal. steel tanks.

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1—Industrial type 316 SS jacketed vacuum double cone blender, 12 cu. ft. working capacity
1—Pfaudler 500 gal. glass lined jacketed reactor with anchor type agitator, complete

AUTOCLAVES, KETTLES AND REACTORS

4—Alco type 316 SS jacketed reactors, 3000 gal.
1—Allied Steel Products type 316 SS jacketed reactor, 750 gal.
3—Type 316 SS 600 gal. jacketed kettles
1—Buflovak SS 300 gal. jacketed reactor
1—Pfaudler type 316 SS 150 gal. jacketed reactor, complete with agitator and drive
1—Steel & Alloy Tank Co. 125 gal. type 347 SS jacketed autoclave, 250 psi jacket and internal
1—Steel & Alloy Tank Co. 350 gal. type 347 SS pressure tank, 250 psi jacket
1—Steel & Alloy Tank Co. 100 gal. type 347 SS pressure tank, 250 psi jacket
1—Blaw-Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket
1—Blaw-Knox 45 gal. jacketed autoclave, 1500# pressure
1—Pfaudler 500 gal. glass lined reactor, complete with anchor type agitator and drive
2—Pfaudler Series R 500 gal. glass lined jacketed reactors, complete with impeller type agitators, baffles and drives
1—Edgemoor Iron Works type 316 SS jacketed reactor, 750 gal.
2—Struthers Wells 500 gal. nickel jacketed reactors
1—Patterson-Kelley 6000 gal. steel jacketed reactor, 40# jacket, complete with agitator and drive.
1—Patterson 2000 gal. steel jacketed reactor
28—30,000 gal. steel vertical storage tanks

DRYERS

3—Link-Belt steel roto louver dryers, Model 207-10, 310-16, 604-20
1—Buflovak double drum dryer 42" x 120"
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
1—Stokes double drum dryer, 5' x 12'
1—Louisville rotary steam tube dryer, 8' x 45'
2—Louisville SS rotary dryers, 8' x 50'
1—Louisville SS rotary kiln, 30" x 28', complete
1—Louisville rotary dryer, 38" x 40', Type L
1—Ruggles Coles 4' x 30' rotary kiln
1—Traylor 4' x 40' rotary dryer
1—Swenson 10' dia. spray dryer
1—Rotary dryer, 6' x 36'

FILTERS

3—Dorrco rubber covered filters, 6' x 2'
1—Sweetland #3 SS filter
1—Feinc SS rotary vacuum string filter 3' x 3' (NEW)
1—Niagara SS filter, Model 510-28
1—Niagara SS filter, Model 36H-110-3
1—Oliver horizontal filter, 3'
10—Shriver plate and frame filter presses, 12" to 42"
1—Shriver rubber lined filter press, 36" x 36"
12—Sweetland #12 filters with 72 SS leaves

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1—Tolhurst SS 20" suspended type centrifuge with perforated basket, complete with motor and plow
1—AT&M 26" suspended type centrifuge with SS perforated basket, complete with motor & plow
1—AT&M 48" SS suspended type centrifuge complete with plow, motor and imperforated basket
1—Sharples type 316 SS Super-D-Hydrator, Model C-20
1—Sharples type 316 SS Super-D-Canter
1—Bird Type 316 SS centrifuge 32" x 50"
4—Tolhurst 30" center slung rubber covered centrifuges with perforated baskets and motors

MIXERS

3—Robinson type 316 SS sigma type jacketed H.D. mixers, 400 gal.
5—Baker Perkins double arm sigma blade mixers, 100 gal.
1—Patterson monel double cone blender, 4 cu. ft.
1—12' x 4' type 316 SS pug mixer
1—Munson rotary blender, 40 cu. ft.
1—Patterson type 347 SS jktd. vac. sigma kneader master, 500 gal.

MISCELLANEOUS

1—Cleaver Brooks 500 HP package steam generator, 200#
1—Ames 300 HP package steam generator, 150#
2—Heat Transfer Products steel bubble cap columns, 36" and 42" with 5 and 10 trays
1—Acme steel bubble cap column, 42" dia. with 10 trays
2—Patterson-Kelley steel heat exchangers, 1000 sq. ft. each
6—Struthers Wells heat exchangers, 885 sq. ft.
1—Patterson-Kelley steel heat exchanger, 427 sq. ft.
50—Steel heat exchangers from 15 sq. ft. to 400 sq. ft.
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
2—Condenser Service type 316 SS heat exchangers, 350 sq. ft.
3—Badger type 316 SS heat exchangers, 500 sq. ft. and 600 sq ft.
1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays

25 Davis Engr. SS heat exchangers, 145 and 230 sq. ft. (NEW)
1—Baker Perkins 5 gal. double arm sigma blade jacketed mixer, Size 8, Type CE
2—Sturtevant SS #7 Dustless rotary batch blenders, NEW
1—Link Belt steel roto louver dryer, Model 1003-30

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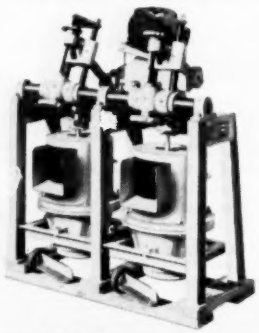

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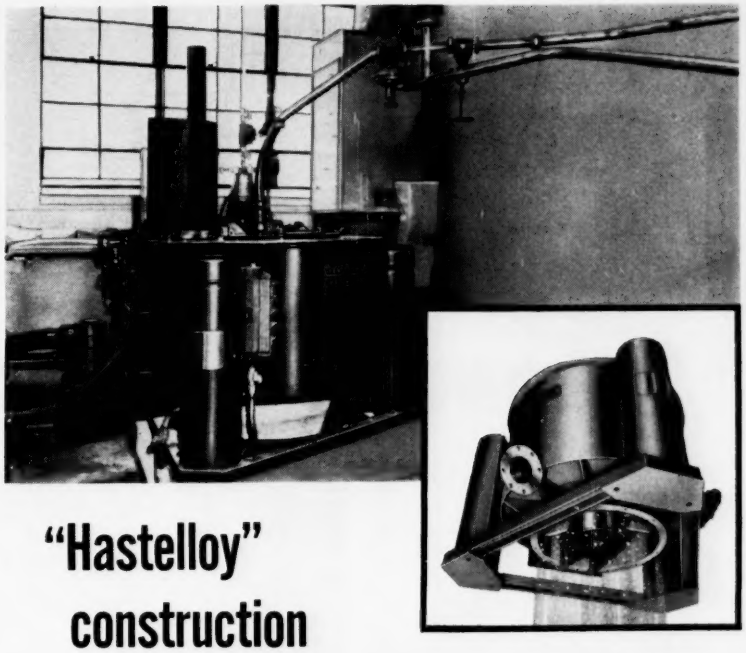

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For handling highly corrosive materials under exacting standards of purity, BATCH-O-MATIC Centrifugals can be constructed of "Hastelloy," Titanium and other special materials available. Tolhurst also offers a wide range of standard alloys to protect product purity of pharmaceuticals and other fine chemicals. This alloy selection adds even greater versatility to the completely automatic BATCH-O-MATIC, which features advantages like "Center Slung"® suspension for handling out-of-balance loads; fast bottom discharge; variable basket speeds and low, compact design. For more complete data, see Tolhurst's section in Chemical Engineering Catalog or write.

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FOR FASTER, more productive filtration of fruit juices, foods, water . . .

This virtually 100% pure cellulose offers more advantages as a filter medium in many food processing applications.

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WHERE THERE'S BUSINESS ACTION THERE'S A BUSINESSPAPER

Some blessings we take for granted. Like ice cubes. Or indoor plumbing. However, older men—wiser men—say a little prayer of thanks for things they know they couldn't do without.

Among these wiser men are the men who make top-level decisions in business.

To make decisions, they must have facts. All the facts. All the pertinent information they can get. And they get a major portion of that information from one unique source: the business publications they subscribe to.

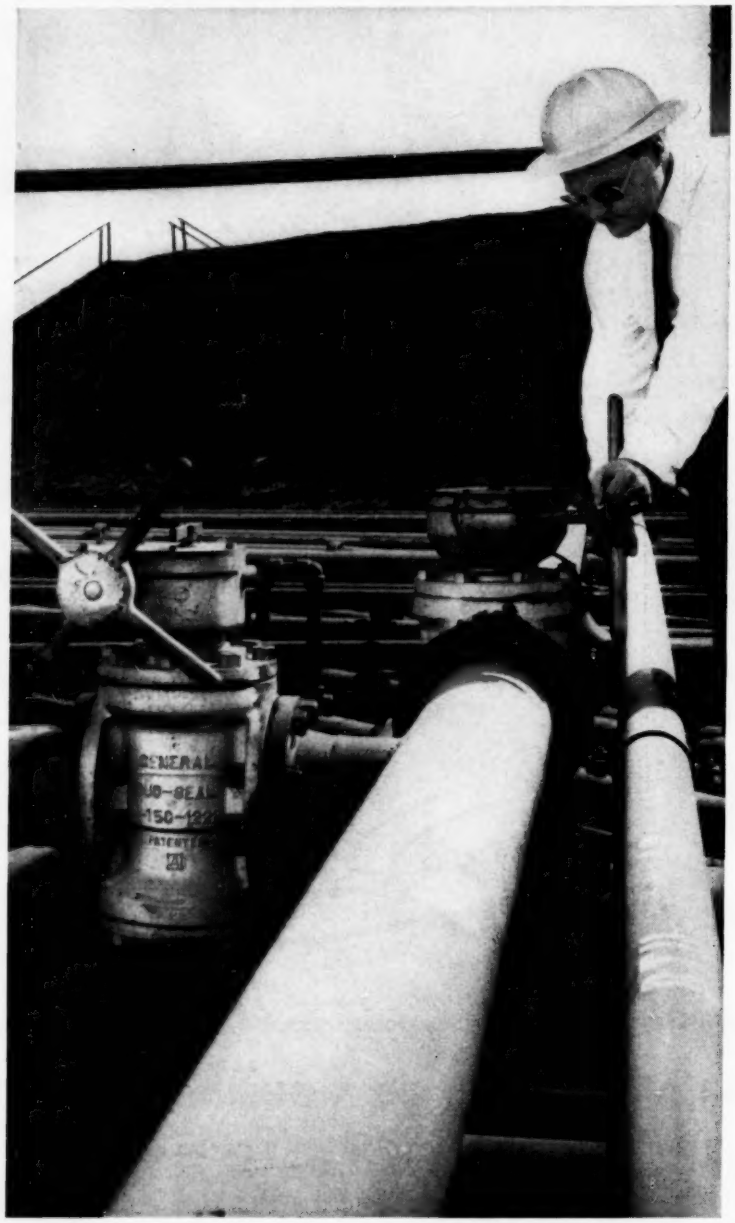
No businessman is fully informed until he reads his businesspaper. He reads it for profit, not for pleasure. He searches it through for news of the trade or industry. For facts. For fresh ideas. For new products he can put to work. And he reads the advertising with the same intense concentration he devotes to the editorial pages.

He knows that his businesspaper is vital to his success—to his very livelihood. And he says a little prayer of thanks.

Every man on the way up can profit from his example. Take a tip from the reading habits of key men at every level. Take out a subscription of your own. Read every issue...and read it searchingly. It's *your* businesspaper, too.

One of a series of advertisements prepared by THE ASSOCIATED BUSINESS PUBLICATIONS

Valve sealed with VITON® still gives positive shutoff after 1 year in benzene line



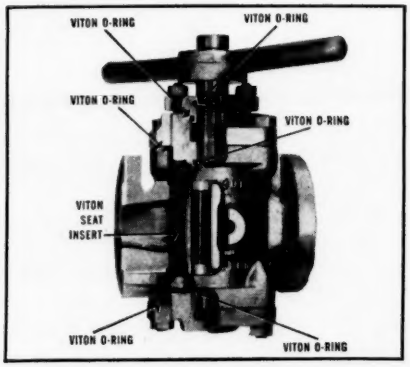
VITON synthetic rubber doesn't swell in the presence of benzene. In these valves at Richfield Oil Company, it has performed well for over a year. Cutaway photo of the valve, right, shows how VITON is used as O-ring and primary seat material.

Here you see a pair of General Duo-Seal Valves in benzene service at Richfield Oil Company's Wilmington, California, Refinery. For more than a year these valves have depended on reliable Du Pont VITON synthetic rubber parts to assure positive shutoff. VITON does not swell in the presence of benzene and other aromatics; it keeps its strength, shape and size—even at elevated temperatures.

Richfield is just one example. Other refineries have successfully used VITON-sealed valves for handling toluene, xylene and blends of these aromatics with other petroleum stocks . . . for 380° F. alkylate gas and for propane at temperatures as high as 400° F.

New Du Pont VITON synthetic rubber offers this kind of resistance to many types of oils, fuels, solvents and corrosive chemicals. Added to this, VITON shows outstanding resistance to high temperatures (450° F. and *up*). It has low compression set, high modulus and good tensile strength . . . plus resistance to ozone, oxygen and weathering.

Such products as gaskets, O-rings, seals, coated fabrics, hose and tubing made from this new synthetic rubber are setting performance records throughout industry. Ask your supplier about the application of VITON parts in your operation. For free booklet describing VITON, write to: E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. CE-10, Wilmington 98, Delaware.



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HYPALON®
VITON®
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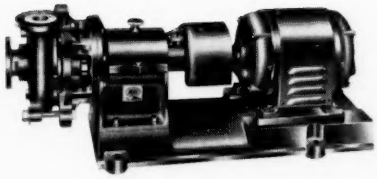
HARD TO HANDLE?
-NOT FOR

WILFLEY
ACID PUMPS

Pumping hot corrosive liquids *efficiently* is standard practice for Wilfley Acid Pumps. Even under the pressure of 24 hour-a-day schedules Wilfley pumps continue to deliver trouble-free performance. Actual production records prove Wilfley consistently gives you higher output and lower pumping costs. Whether you are pumping corrosives, hot liquids or mild abrasives, there's a Wilfley Acid Pump that will do the job for you.



Pumping parts are available in a variety of metal alloys, as well as plastic, to cover a wide range of corrosive applications. 1 inch to 8 inch discharge sizes with 10 to 3000 GPM capacities and heads up to 200 feet.

Write, wire or phone for complete details.

Individual Engineering on Every Application

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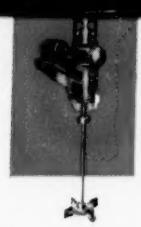


Will you reap the long-term payoff
of good mixer shaft sealing?

If you want to minimize your mechanical fluid mixing costs, take a hard look at *mixer shaft sealing.*

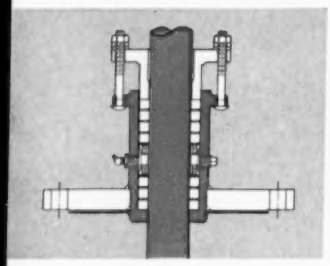
This is the area where profits can leak away unnoticed. The right shaft seal makes all the difference between an efficient mixing operation and a ruinously expensive one.

When you're aiming for low-cost shaft sealing, *don't be fooled* by low first cost. Instead, look for solid long-range savings you can make in terms of *smooth operation, rapid maintenance, minimum downtime.*

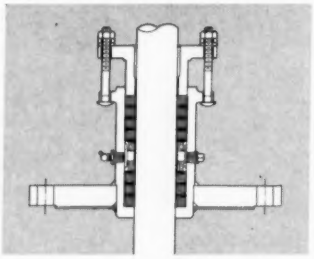
Here are some mechanical reasons why you get these savings with LIGHTNIN Mixers. Every one of the features illustrated below is a LIGHTNIN "first." Many are yours only with LIGHTNINS. And only LIGHTNINS give you *all* of them!

For lowest-cost fluid mixing, see your LIGHTNIN Mixer representative soon. Look him up in Chemical Engineering Catalog. Or write us direct.

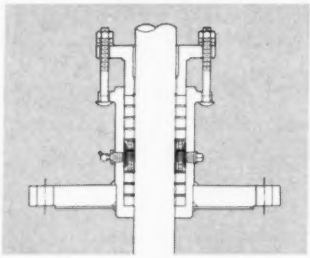
How you cut mixing cost with the *Lightnin* stuffing box



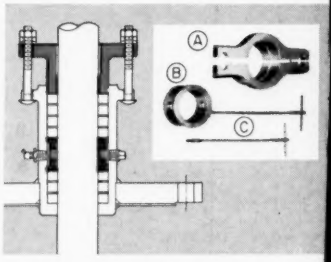
1. SAVE COST of a special-alloy mounting flange with all-welded LIGHTNIN construction. Forged steel flange is faced with correct alloy for your process conditions. Hub is solid alloy. Alloy parts are shown in color.



2. GET SUPERIOR SEALING with 7 rings of large-cross-section packing. Separators facilitate packing removal, distribute force uniformly. Gland bolts, threaded part way, prevent overtightening.



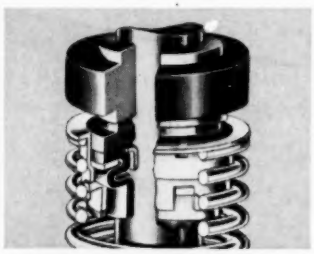
3. GET BETTER LUBRICATION without repacking. Lantern ring evenly distributes lubricant; permits continuous lubrication under pressure; extends time between repackings. Relief plug prevents overlubrication.



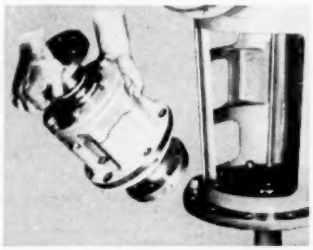
4. REPACK FASTER with exclusive split packing gland (A) that comes right off the shaft to allow maximum work space. Lantern ring (B) lifts out quickly by means of pullers (C), standard accessories.

Get simplest possible maintenance with *Lightnin* mechanical seal*

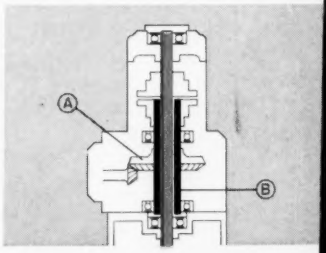
1. ELIMINATE REPACKING and adjustment with this cartridge-type LIGHTNIN rotary mechanical seal assembly, optional on all LIGHTNIN Mixers. It's saving many users thousands of maintenance dollars a year.



2. GET WIDEST CHOICE of seal designs and materials to meet your conditions: stainless steels, Stellite, Hastelloy alloys, bronze, ceramic, Teflon, etc. Handle pressures to 2500 psig and all temperature ranges.



3. REPLACE SEAL ASSEMBLY quickly, if ever necessary—without dismantling mixer or removing it from tank, and *without skilled manpower.* Seal cartridge unbolts, comes out as a unit; replacement bolts in.



4. RETAIN GEAR ALIGNMENT when changing seal. Mixer gears (A) are isolated from shaft by hollow drive quill† (B) —*cannot get out of line* when seal is removed. Shaft realignment is automatic on reassembly.

†patented

WHAT MIXING OPERATIONS are important to you? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 128-k Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

Lightnin® *Mixers*

MIXCO fluid mixing specialists

*patent pending